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OIL PALM IN MALAYA.

BY B. BUNTING AND C. D. V. GEORGI.

THE Oil Palm, *Elaeis guineensis*, the fruit of which yields the two well-known oils of commerce, palm oil and palm kernel oil, is indigenous to West Africa. The collection of the fruit and the extraction of the oil are important native industries in those regions.

This palm was introduced into the Netherlands East Indies in 1848, but did not receive serious consideration as a plantation crop until the last decade, when the demand for vegetable oils and fats had increased to such an extent as to encourage the cultivation of oil-yielding crops. During this period considerable progress has been made in the Netherlands East Indies where, according to Rutgers,* the area planted with oil palms in the east coast district of Sumatra had increased from 8,500 acres in January 1918 to 28,000 acres in January 1922.

Attention was drawn to the possibilities of this crop by the Department of Agriculture in an article published in the Agricultural Bulletin, Vol. VI, No. 11, September and October 1918. At that period a few acres on one estate had already been planted. Since then the cultivation of the palm has been extended on the estate previously mentioned and other areas have been planted, until at present the total area under cultivation in this country amounts to approximately 5,000 acres, of which 1,000 acres are in bearing. The export of palm oil and palm kernels has already commenced. Numerous applications for land, together with enquiries for information in respect of the cultivation, have recently been made, which show that the possibilities of the crop are now being realised by the local planting community.

A small area at the Government Experimental Plantation, Serdang has also recently been planted with this palm with a view to investigating the various problems connected with its cultivation.

* "Investigation on Oil Palms" by Dr. A. A. L. Rutgers.

VARIETIES.

Although different varieties of oil palm have been described, based primarily on the character and composition of the fruit, it is somewhat doubtful whether there are any definite fixed types, and breeding experiments will have to be carried out to determine this point.

The "Deli" type, which is in general cultivation in Sumatra and this country, is considered to be most suited to local conditions, and it is doubtful whether it will be superseded by other varieties from indigenous palms in West Africa.

The composition of the fruit may vary in respect of (a) the percentage of pericarp and its oil content, (b) the percentage of kernel and its oil content, (c) the thickness of the shell. Improvement may be effected by selection work on the existing varieties, to produce a type with fruit giving (a) the maximum amount of pericarp with a high oil content (b) a thin shell with the maximum amount of kernel of high oil content. In selecting parent trees, allowance will have to be made for alteration in type due to external environment, which may have a greater effect than genetic constitution.

CULTIVATION.

The most suitable soil for the oil palm is an alluvial loam overlying a clay subsoil, which will permit of easy root penetration and retention of moisture. Light sandy soil or swampy land is unsuitable. Although it may be grown successfully on gently undulating land, the flat coastal land, provided it can be properly drained, is likely to give the best results.

In low-lying land, common in the coastal districts, *rantas* are first made through the jungle and the main drains cut immediately, in order to dry the land as much as possible before felling is commenced.

The oil palm is propagated from seed, the time taken for germination varying considerably, depending both on age of the seed and method of treatment in the propagating beds. Seeds imported from West Africa, which have dried, or those which are either unripe or over ripe, germinate very slowly, whilst even good ripe seeds obtained locally, when sown as fresh as possible, may by no means germinate rapidly. This is a serious drawback when a definite planting programme has been arranged and, special attention must be given to the method of propagation in order to accelerate germination.

The most satisfactory method of germination is to collect only ripe seeds and, after removing the pericarp, to sow them at once, just below the surface, in specially prepared beds consisting of pure sand about 1 foot deep. The beds are exposed to the sun and kept moist by constant watering. Immediately the two leaf sheaths appear above the surface, which may take from 2 to 3 months, the seedlings are removed from the sand beds and planted about 1 to 1½ feet apart in

specially prepared nursery beds on good flat land. The seedlings remain in these beds until ready for transplanting into the field, which may be from 8 to 10 months according to the season when they were planted in the nursery beds.

After felling and burning operations are finished, the land is clean-cleared and prepared for planting. The most suitable distance of planting in the field is 30 ft. $\times$ 30 ft. triangular (equilateral), giving approximately 55 palms per acre. The area should be carefully lined and holed for planting. The holes, usually 2 feet square and 2 feet deep, are filled with good surface soil and the seedlings planted with the base of the young leaves just above the level of the ground. Deep planting should be avoided. The oil palm stands transplanting fairly well under ordinary conditions, and very little supplying is necessary. After planting, the land should be clean weeded and, to develop the feeding roots, the surface soil at the base of the palm should be kept in a friable condition by digging or forking at least once every three or four months.

As an alternative to clean weeding, leguminous cover crops may be established in the first year of growth. These will reduce the cost of weeding and, at the same time, increase the fertility of the soil. When the young plants begin to develop, growth may be further improved by surface cultivation with ploughs or disc harrows. On peaty land, where the soil is apt to subside after it is opened, mounding or banking of the young plants may be necessary, and this operation may have to be continued until the land has settled down to its normal level. On low-lying land drainage operations will have to be carried out, since the oil palm will not thrive in a water-logged soil.

On undulating land steps should be taken to prevent soil wash; this is done preferably by (a) planting low-growing cover crops, (b) silt-pitting, or (c) terracing, all of which tend to arrest the erosion by diminishing the force of rain water which carries away the finer particles of the surface soil.

Although catch crops are not generally recommended, they are sometimes cultivated in the early stages of development in order to provide revenue until the palms come into bearing. On areas where the soil is suitable for the cultivation of coffee, Robusta or its hybrid varieties may be grown with a certain degree of success.

When the palms come into bearing at the end of the third or fourth year after planting in the field, a regular system of pruning the leaves at the base of the palm is necessary. The leaves just below the growing bunches of fruit should not be removed until the fruit is almost ripe and ready for harvesting. The pruning operation should be carried out carefully, since the fruit production of heavily pruned palms decreases rapidly. Pruning is now practically restricted to the removal of those leaves having a ripe bunch in their axils.

POLLINATION.

Observation on young or isolated palms have shown that natural pollination does not always take place, which has led to experiments

being conducted on artificial pollination. The male and female inflorescences are produced on the same palm, but not necessarily at the same time and, since the flowers on the female inflorescences remain in a receptive condition for a period of only 2 to 3 days after the opening of the flowers, it is frequently necessary to obtain pollen from a male inflorescence on another palm, otherwise the flowers may not be fertilised.

When artificial pollination is necessary, a ripe male inflorescence, denoted by its strong smell of aniseed, is selected; after careful removal from the palm it is held over a funnel and shaken so that the pollen grains fall into a suitable receptacle placed beneath the funnel. The pollen should be collected in the afternoon and dusted on the receptive female inflorescences on the following morning.

While artificial pollination may be advisable in the case of young palms, it may be found unnecessary in the case of older palms which may be pollinated sufficiently by natural agencies. Experiments in artificial pollination have shown that it can be carried to excess, and it remains to be determined to what extent it can be carried out successfully in actual practice over a continuous period. In some cases, more particularly on poor land, over-pollination by artificial methods has resulted both in the reduction of the size of the fruit and the percentage of pericarp.

Special attention will be given to the artificial pollination of the palms planted on the Experimental Plantation, Serdang.

PESTS AND DISEASES.

The oil palm hitherto has not suffered greatly from the attacks of insect pests or fungoid diseases; but the risk of both pests and diseases will naturally be greater when large contiguous areas are planted.

Among insects pests, the coconut beetle (*Oryctes rhinoceros*, Linn.) and the red-stripe weevil (*Rhynchophorus schach*, Oliv.) have been found doing damage, the latter having been known to kill palms by boring through the main stem.

The only disease so far reported, and which appears to be confined to young palms, is the "crown disease." This disease is indicated by a weakening of the leaf stalk of the young leaves, which become bent and fall over, giving the crown a twisted appearance. As a rule, after some time, new leaves are formed and the palm recovers its normal appearance.

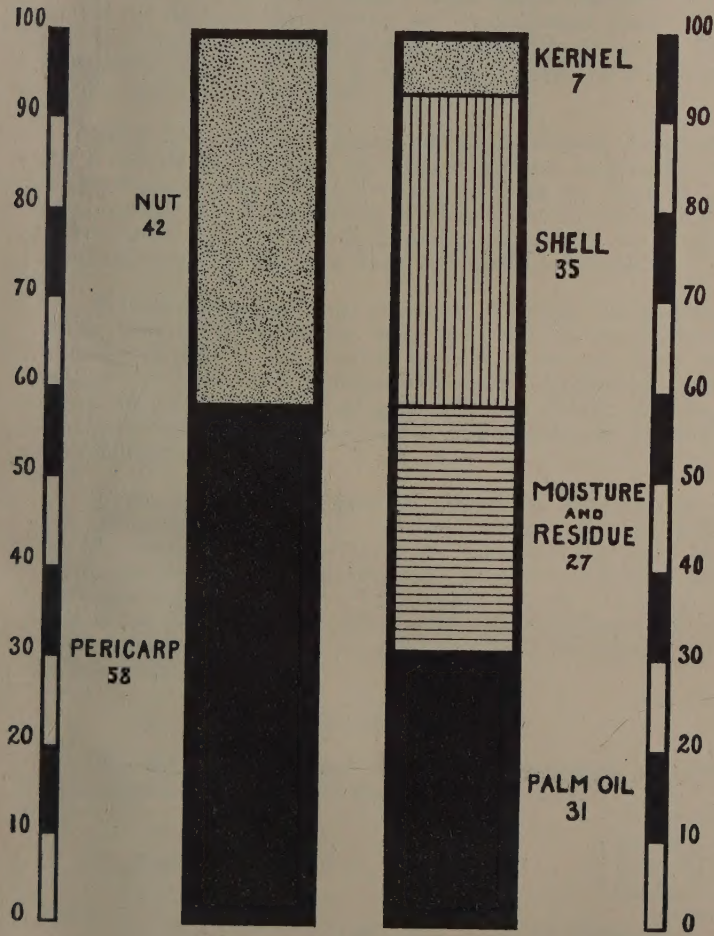
Other pests which may be mentioned are rats, pigs and porcupines, which must be exterminated by the usual methods, such as poisoning or trapping.

HARVESTING.

As previously stated, the palms come into bearing at about the third or fourth year after planting, and the fruit ripens about six

COMPOSITION OF OIL PALM FRUIT.

PERICARP AND NUT. ULTIMATE COMPOSITION.



months after pollination. The crop is not evenly distributed over the year, the maximum crop being obtained during the dry season and the minimum during the wet season; the maximum production per month is about double the average monthly production.

The fruit bunches are gathered systematically as soon as they are ripe and conveyed to collecting sheds, in which they are stored on open racks for 3 or 4 days until the fruits fall from the bunch on to trays placed below. The fruit is then collected and transported to the factory, where the oil is extracted. Great care is necessary in the handling of the fresh fruit; under no circumstances should it be allowed to remain in heaps, otherwise fermentation is caused by a fat-splitting enzyme present in the pericarp resulting in a large increase in the acidity of the oil.

Experiments have been carried out at the General Experiment A.V.R.O.S., Medan, Sumatra employing a threshing machine for the mechanical separation of the fruits from the branches, since it has been suggested that, when working on a large scale, the method of first separating the fruits in the field, in addition to requiring the erection of a large number of collecting sheds, may not be practicable.

In these experiments it was found that, although the separation of the fruit could be effected much more rapidly, the fruit was so bruised as to cause a considerable increase in the free fatty acid content. If, however, the branches of fruit were sterilised by immersing in boiling water before passing through the threshing machine it was found that there was no increase in the free fatty acid content of the resultant oil.

As compared with the previous method the disadvantages are that approximately twice as much material (about half being waste) must be transported from the field to the factory and that larger heating vessels are required. The advantages are that no collecting sheds are necessary and that labour is considerably reduced. It is not yet possible to give details in regard to the difference of working costs between these two methods, since the two have not been compared in this country.

COMPOSITION OF FRUIT.

This following table and the chart on the opposite page show the average composition of the fruit from this country.

				per cent.
FRUIT	{	Pericarp 58 per cent. 	{	Moisture 33
				Palm Oil 53
				Residue 14
	per cent.			
{	Nut 42 per cent.	{	{	Palm Kernel Oil 43
				Moisture " 15
				Residue " 42

Proportion of Palm oil on whole fruit = 31 per cent.

Proportion of Kernel on whole fruit = 7 per cent.

ANNUAL YIELDS OF OIL PALMS.

Individual palms may produce from 6 to 10 bunches of fruit per annum, whilst the weight of picked fruit may vary from 45 to 145 lbs. per palm per annum according to age.

The following are estimates based on palms planted 55 per acre and calculated on the yields of pericarp, palm oil and kernel given above.

Age of Palm.		Fruits per palm per annum.	Fruit per acre.	Peri- carp per acre.	Palm Oil per acre.	Palm Oil Output per acre (85% basis.)	Ker- nels per acre.
		lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
4th	year	45	2475	1436	767	652	173
5th—7th	„	90	4950	2872	1534	1304	346
8th—10th	„	100	5500	3190	1705	1449	385
11th—15th	„	125	6875	3988	2131	1811	481
16th—30th	„	145	7975	4626	2472	2101	558

The above is a conservative estimate and it is probable that under good conditions these yields will be exceeded.

EXTRACTION OF OIL.

The oil palm fruit contains two distinct oils, namely, palm oil, present in the pericarp and palm kernel oil, contained in the kernel. As previously stated, the preliminary treatment of these fruits calls for special attention since there is present in the pericarp an active fat-splitting enzyme. It is important that the fruit be picked when ripe and treated while still fresh, otherwise a large part of the oil will be decomposed, with the formation of an abnormal proportion of free fatty acids. With care, this acidity can be kept below 5 per cent; but if the fruit be left untreated for some time after gathering and the oil extracted by the primitive native method employed in West Africa, boiling out with water, it may contain up to 50 per cent. of free fatty acids.

The method adopted to obtain palm oil of high quality consists in a preliminary heating of the fruit to destroy the ferment; the hot fruit is then pressed in order to obtain as much of the oil as possible without cracking the nut. The partially expressed pericarp is then stripped from the nuts in a special machine known as a depulper or depericarper and, after drying, is pressed again to obtain the remainder

of the oil. The fibrous residue is used as fuel, having no value as a feeding stuff or fertiliser.

Mention might also be made of a modification of the method of extraction involving the use of a centrifugal extractor. In this modified process, the fruits are steamed and charged into the extractor in which the greater proportion of the oil and moisture is removed. The centrifugal action also facilitates the separation of the nuts from the fibrous residue, which is then pressed as described in the process. It may be necessary to treat damaged fruits separately.

The oil is then allowed to settle and is strained into casks for export. Care must be taken in the selection of the casks, oak staves being preferable in order to minimise the loss arising through leakage. Casks of standard size are employed, 10 tons of oil requiring about 15 casks.

EXTRACTION OF KERNELS.

After separation from the fibre, the nuts are dried and cracked in a nut cracking machine, the kernels being separated from the shells by flotation in brine or clay suspended in water. The kernels are then dried, the shells being used as fuel.

The oil from the kernels is usually obtained by hydraulic expression. The kernels are ground and hot-pressed twice on account of their high oil content. The residue, which still contains a small percentage of oil, is used as a feeding stuff.

In view of the demand for palm kernels in the home markets it is unlikely that palm kernel oil will be manufactured in this country; it is therefore preferable to export the dry kernels rather than the oil and cake separately.

USES.

Palm oil finds a varied application in industry according to its free fatty acid content. While an oil of medium quality is employed largely in the preparation of soaps, candles, lubricating greases and in the manufacture of tinsplate, an oil with a minimum quantity of free fatty acids, from 2 to 4 per cent, can be used for edible fats. Hitherto the quantity of such high grade palm oil available has been limited; but, with regular supplies, it should be able to compete as an edible fat with either coconut or palm kernel oil, since it has been proved that high quality palm oil forms an excellent basis for the preparation of substitute butter and cooking fats.

As stated above, palm kernel oil is used chiefly in the manufacture of edible fats, smaller quantities being employed in the soap making industry. Palm kernel cake constitutes an ingredient of many feeding stuffs.

VALUE OF PRODUCTS.

The present London quotations (March 1924) for oil palm products are approximately as follows:—

Palm oil (Lagos)	... £40.5.0 per ton.
Palm kernels	... £20.0.0 „ „
Palm kernel oil	... £45.0.0 „ „
Palm kernel cake	... £ 7.0.0 „ „

The quotation for Lagos palm oil applies to an oil with a free fatty acid content of 18 per cent., calculated as palmitic acid. A premium of 1s. 9d. is paid for each per cent. of acidity below the standard, thus a premium of $15 \times 1s. 9d. = £1. 6s. 3d.$ per ton extra would be paid for an oil of only 3 per cent. acidity. It is possible with careful preparation to keep the acidity of palm oil, produced under plantation conditions, within this limit. This premium for palm oil having a low free fatty acid content was based on the native prepared oil received in the European markets from Africa and is not commensurate with the extra expense involved in the production of such a high grade product as can be prepared under plantation conditions. It is understood that the revision of this premium is at present under consideration.

CONCLUSIONS.

From actual experience gained in the cultivation of the oil palm in this country, it is considered that this is a crop well worth development on a plantation scale. The yields recorded locally are sufficiently promising to warrant the outlay of further capital for this industry, and its considered that the return on the capital invested will undoubtedly be greater than that obtained from the cultivation of coconuts. In this connection the details given below, comparing the returns which may be expected under normal conditions from both coconuts and oil palm in full bearing may be of interest. It should be borne in mind that the estimates for the African oil palm are based on figures previously given and are therefore a forecast, since there is no plantation in this country on which the palms are in full bearing.

Returns from Coconuts.—A good coconut plantation in full bearing should produce an average of 60 nuts per palm per annum, which, with 55 palms per acre, will give 3,300 nuts per acre per annum, equivalent to a yield of 16 cwt. of copra per annum.

The actual return from 1 acre of coconuts at current prices would therefore be as follows:—

16 cwt. of Copra at £29.10.0 per ton = £23.12.0.

Returns from Oil Palm.—Reference to the table previously given will show that the estimated yield from palms in full bearing, allowing only 85 per cent. extraction of the theoretical figure for the

oil content, is approximately $18\frac{3}{4}$ cwt. of palm oil and 5 cwt. of kernels per acre per annum.

The actual return from 1 acre of oil palms at current prices would therefore be as follows:—

$18\frac{3}{4}$ cwt. of Palm oil at £40.5.0 per ton = £37.14.8

Add premium at 1s. 9d. for 3% acidity = 1. 4.6

5 cwt. of Palm kernels at £20.0.0 per ton = 5. 0.0

£43.19.2

Although the return from palm oil is considerably greater than that from coconuts exported as copra, it must be remembered that both the preparation of the palm oil and the extraction of the kernels involve a heavy outlay for plant and machinery. This additional expense must therefore be taken into account when making a fair comparison, since no machinery is required for the preparation of copra.

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FURTHER REPORT ON NIPAH PALM.

By B. J. EATON AND J. H. DENNETT.

A Preliminary and interim report on the investigation of Nipah Palm was published in the *Malayan Agricultural Journal*, Volume XI, No. 3, March 1923.

During the period which has elapsed since the publication of the above report, tapping experiments have been continued. A large number of estimations have been carried out on the sugar content of the juice and an investigation has been made in connection with the disappearance of alcohol from the juice after standing for some days.

The question of the sugar content of the juice is most important to the alcohol manufacturer, who as far as possible requires to standardise his "mash."

SITUATION OF TAPPING AREA.

The investigations through out the year have been carried out on palms situated at the $15\frac{1}{4}$ mile Klang-Kuala Selangor Road.*

DESCRIPTION OF AREA.

Experimental tapping was commenced on palms on this area in February 1923. The palms on the area at the commencement of tapping were far from being under optimum conditions, and had been cut for attap manufacture; while none of the palms were in drains. The land is not flooded except at certain periods during the rainy season and all the palms were situated at some distance from the sea sub-drain.

Observation on yields this year have been less difficult since, although the tapping has not been under the continuous daily supervision of a European Officer of the Department, a large amount of supervision work has been done by Mr. N. Fish of Bukit Ijok Estate to whom thanks in this connection are due.

CONSTRUCTION OF EXPERIMENTAL CATCH DRAINS.

About two months after tapping was commenced, a catch drain was dug round a certain group of palms in order to ascertain whether any changes in the yields were produced by such means. The drain was circular and was constructed so that no palm was actually in the drain, the whole group being situated within, and at a distance of two to three feet from it. In order to have all the palms in the group situated at the same distance from the water a diametric cross cut was made.

The results obtained (see Table II) show the marked effect of the drain in increasing the yield of juice.

* See M.A.J. Volume XI, No. 3, March 1923, p. 51 first paragraph.

OBSERVATIONS ON TAPPING.

In the previous publication (vide supra) on the investigation it was stated that experiments would be carried out to endeavour to reduce the period of preliminary treatment by tapping the immature flower stalk; the mature fruit stalk was also prepared in a manner similar to that which is used by toddy tappers in tapping the Coconut spathe.

No satisfactory results were however obtained by these methods. On tapping the immature flower stalk a few cubic centimetres of juice were obtained for two or three days, after which the stalk withered. No juice was obtained from stalks treated by toddy tapping methods.

The most striking and important observation on the tapping experiments this year is the fact that the palms have been yielding juice for the whole twelve months of tapping. Such an observation may not appear very important until it is remembered that in all other countries where nipah is indigenous the tapping is seasonal and ranges from four to six months. This confirms the statement of many Malays who have been questioned in regard to this matter.

On the other hand it is still uncertain whether the palms can be tapped continually year after year. It is possible, although from recent observations it does not seem probable, that a palm may be killed by continued tapping. The next two to three years should prove or disprove such an idea.

From the quantitative point of view the yields are of great interest as the summary in Table I will shew.

The average numbers of Palms as Distinct from "Stands" in Tapping during any month. Although Variable, is certainly not more than half the number indicated in column 4 of the Table I.

During the months of November and December 1923 and January 1924 it is known that the palms in tapping average not more than one third of the stands indicated.

The figures shew conclusively that a yield of one quarter of a gallon per palm per day, indicated in the previous report, can be maintained over a whole year. Whether these yields can be maintained perennially is still in process of being ascertained.

Records for February 1924, so far as is known at the time of writing, indicate increased yields. The results obtained certainly encourage further work on the problem.

The last column of Table I indicates approximately the percentage of palms (not "stands") which yield not less than $\frac{1}{4}$ gallon per diem. It will be seen that the percentage has risen from 25 at the commencement of tapping to 75 in January 1924.

The gradual increase in yields which is being shewn as tapping proceeds, is probably due largely to the fact that for a period of twelve months no stands have been cut for attap manufacture. Yields and period of tapping of a number of spathes (as distinct from stands or palms) are given in Table II. These yields have not been selected but are taken in order as they occur in the tapping records.

TABLE I.—Yields for 1923.

Month.	Days tapping.	Vol. of Juice per month (gallons.)	Mean No. of stands† per month.	Mean per stand† per month (gallons.)	Maximum per day for any stand† (gallons.)	Minimum per day for any stand† (gallons.)	Percentage of palm giving not less than $\frac{1}{4}$ gallon per day.
February	12th—28th	14.405	12.6	1.15	0.3	0.006	25
March	1st—31st	54.405	21.5	2.06	0.33	0.006	35
April	1st—30th	84.250	21.6	3.90	0.38	0.031	45
May*	1st—31st	61.000	15.0	4.10	0.43	0.031	35
June	1st—30th	34.312	10.4	3.30	0.20	0.031	45
July	1st—31st	52.600	20.2	2.60	0.43	0.031	45
August	1st—31st	43.350	10.4	3.80	0.37	0.031	50
September	1st—30th	68.638	19.0	3.62	0.38	0.031	50
October	1st—31st	109.540	27.0	4.00	0.36	0.042	55
November	1st—30th	104.200	30.0	3.47	0.36	0.031	60
December	1st—31st	114.700	30.0	3.82	0.47	0.031	73
January	1st—31st	119.675	24.3	4.10	0.42	0.031	75

* Many stalks finished tapping. New stalks started.

† The word "stand" is used to distinguish from a whole palm. It should be noted that from a single seed three or four "stands" of nipah grow which together constitute one palm.

The formation may be compared to the shape of the ace of clubs, so that if palms are planted at 300 per acre there will be between nine and twelve hundred "stands."

TABLE II.

Yields of juice from individual spathes in Gallons.

Spathe.	At commencement of tapping.		At time of writing.		Remarks on two previous columns.
	Period of flow (days.)	Yield (gallons.)	Period of flow (days.)	Yield (gallons.)	
A	125	28.5	60	9.3	Still flowing.
B	71	10.0	202	45.0	Ceased from 5th January.
C	97	14.1	95	14.8	Still flowing.
D	110	20.4	56	5.5	Ceased December 24th. Greater Yields were obtained on intermediate stalks.
E	124	16.5	130	15.1	Still flowing.
F	72	7.1	92	28.5	Do.
G	66	3.7	117	9.5	Do.
H	32	1.2	96	6.3	Ceased December 30th.
I	165	8.3	155	17.6	Still flowing strongly.
J	44	1.3	158	11.2	Still flowing.
K	1 Negligible	...	115	8.9	Ceased January 23rd.
	2 55	1.7	125	10.0	Still flowing.
L	1 Negligible	...	167	17.2	Still flowing (2 spathe).
	2 92	7.6	92	12.7	Still flowing.
M	94	7.0	152	11.4	Do.
N	40	1.0	103	9.1	Do.
O	46	2.0	48	4.6	Ceased December 29th.
P	47	1.3	126	10.0	Still flowing.
Q	41	1.3	114	15.6	Finished 11th January.
R	85	8.2	15	1.0	Just starting. Maximum in about 6 weeks.
S	81	5.7	98	9.0	Still flowing.
T	45	1.1	90	4.0	Ceased 25th January. Not yet reached maximum.
U	39	1.3	31	1.8	Still flowing.
V	98	7.1	151	17.4	Ceased January 11th.
W	67	2.7	189	42.2	Two spathes part of time.
X	68	3.4	36	4.7	Still flowing strongly.
Y	96	5.7	39	2.7	Almost ceased. Very poor.
Z	58	1.9	103	16.1	Ceased January 11th.

OBSERVATIONS ON TABLE II.

The letter in column I indicates the "stand" concerned.

Columns 2 and 3 given period of flow and yield in gallons of individual spathes after the commencement of tapping in February

1923, while columns 4 and 5 give the period of flow and yields to date of other spathes at present being tapped on the same "stands."

In certain cases the spathe has ceased to yield and another has not yet come into tapping on the same "stand," in which case the date of cessation of flow or tapping is given in column 6. With the exceptions of the spathes on "stand" D which yielded well from the commencement, "stand" Y which has shewn poor yields throughout and "stand" E which has remained constant, a very marked increase in the yields is shewn at the end of the period of twelve months.

With not more than three exceptions latterly each spathe during some period of the flow, has yielded twenty fluid ounces per diem, which based on two stands per palm yielding at any one time an only one spathe per "stand" gives a yield of $\frac{1}{2}$ gallon of juice per day. (This increases the percentage of palms yielding $\frac{1}{2}$ gallon of juice per day to 90). This is of interest but should not be allowed to weigh too heavily in the calculation of essential yields.

It will be seen also that the average period of tapping per spathe is between three and four months. It is of interest to note that spathes A.B.C.D.E. & F. were on palms surrounded by catch drains.

FURTHER CHEMICAL INVESTIGATIONS OF JUICE.

Chemical investigations on the sugar content and rate of deterioration of the juice were carried out during the latter half of the year.

As on previous occasions, for purposes of examining the sugar content, the juice was preserved with alcohol. It was subsequently estimated by means of the saccharimeter and fehling's solution.

The sugar content, the volume of juice (in fluid ounces on the date on which the sugar content was estimated and the product "volume of juice $\times$ sugar content," i.e. the yield of sugar in ounces per day, is given in table III.

TABLE III.

Date.	Spathe No.	Sugar content of juice (per cent.)	Vol. of juice in fluid ozs	Yield of sugar in ozs.
16-7-23	2	17.15	48	8.23
17-7-23	2	17.15	49	8.40
17-7-23	1	15.4	32	4.92
18-7-23	1	15.4	32	4.92
18-7-23	4	18.5	31	5.75
19-7-23	11	26.3	32	8.41
19-7-23	7	19.1	38	7.25
20-7-23	20	22.8	21	4.78
20-7-23	21	22.3	19	4.25

Date.	Spathe No.	Sugar content of juice (per cent.)	Vol. of juice in fluid ozs.	Yield of sugar in ozs.
8-8-23	2	14.2	59	8.36
8-8-23	1	15.0	36	5.40
9-8-23	2	14.0	53	7.42
9-8-23	1	15.6	35	5.46
10-8-23	2	16.2	51	8.26
11-8-23	2	13.9	33	4.59
11-8-23	2	15.3	52	7.95
12-8-23	1	14.1	37	5.21
12-8-23	2	14.0	64	8.95
12-8-23	3	16.0	25	4.00
23-8-23	20	21.2	22	4.66
24-8-23	20	21.8	26	5.66
25-8-23	20	15.9	19	3.02
26-8-23	20	19.1	19	3.62
27-8-23	20	8.0	24	1.92
29-8-23	20	10.2	24	1.92
30-8-23	20	10.2	24	2.44
9-9-23	2	14.3	63	9.00
10-9-23	2	13.0	48	7.25
11-9-23	2	14.6	54	7.88
12-9-23	2	16.1	55	8.85
14-9-23	2	15.3	54	8.25
15-9-23	2	14.7	59	8.67
16-9-23	2	15.4	61	9.42

It is will be seen that there is a great variation in the sugar content of different palms and also variations in the daily content of individual palms.

For palms giving normal yields, the sugar content appears to average five to six ounces per diem except at the commencement and end of tapping, although it should be noted that the results obtained on only seven palms are included in this table.

Calculation of the sugar content of palms included in the previous report also indicated a yield of five to seven ounces daily.

FURTHER PRELIMINARY INVESTIGATION ON THE KEEPING PROPERTIES OF THE PRESERVED JUICE.

Investigations on the keeping qualities of the preserved juice were carried out in conjunction with the Plant Physiologist.

Experiment 1.—Three half gallon samples of the semi-fermented juice were collected from the unwashed porous native collecting pots.

One of these samples was treated with 20 ccs decinormal sulphuric acid, the second was treated with a small amount of toluene, and the third was used as a control.

Portions from these samples were distilled after four days with the following results:—

TABLE IV.

			Alcohol (per cent.)
Samples treated with sulphuric acid	...		5.45
do	toluene	...	4.80
	Control	...	7.90

An attempt was also made to estimate the residual sugar by use of the saccharimeter, but this was a failure possibly owing to the fact that the wild yeasts which attack the two hexese sugars, resulting from the inversion of the sucrose, do not react so vigorously with the levulose as with dextrose.

The above results indicate that sulphuric acid might be used to prevent premature fermentation if it is required to manufacture alcohol with specific yeasts, the acid being subsequently removed at the distillery by the addition of the calculated quantity of lime.

An acid is useless if it is desired to manufacture sugar, since the acid, while preventing fermentation, greatly assists inversion with the production of the very undesirable invertose.

Owing to the high alcohol content figure obtained for the control sample above, further samples were collected for investigation of the keeping properties.

Experiment 2.—Three samples of the semi-fermented juice were obtained direct from the collecting pots and portions of these were removed at intervals for the determination of alcohol and residual sugar.

The results obtained are given in table V. The juice was collected on the afternoon of November 4th.

TABLE V.

Date.	Sucrose per cent.	Invert sugar per cent.	Acidity per cent.	Alcohol per cent.	pH Value.
5-11-23	0.8	2.0	0.25	6.4	3.5
6-11-23	0.02	0.10	...	7.3	...
7-11-23	0.02	0.07	0.35	...	3.5
10-11-23	nil	trace	0.516	6.9	...
14-11-23	nil	nil	0.516	6.6	3.5
15-11-23	nil	nil	0.510	6.5	3.5

The results confirm those published previously for a somewhat similar experiment, on juice collected from the spathe in glass vessels. In the above experiment the collection was made in unglazed semi-porous earthenware pots to which the greater inversion and fermentation are due.

It will be noted that the pH value, is constant throughout.

The results in the above table also confirm the statement made in the previous publication that conditions here differ very considerably from those in the Philippines.

The bottles in which the juice was contained were not corked, but were left open in order that there should be as little check to fermentation as possible.

Determinations on the fresh juice, taken at the same time as the above samples, shewed a sucrose content of between 16 and 19 per cent.

The efficiency of the natural fermentation process therefore, based on the above figures, is about 75 per cent, against 95 to 97 per cent which would be obtained in good commercial practice.

DEPARTMENTAL SUB-COMMITTEE.

A departmental sub-committee consisting of the Agricultural Chemist, Agriculturist, (Government Plantations,) and Plant Physiologist was formed some months ago to deal more fully with Nipah Palm.

Work will in future be carried out by a member or members of this committee, according to its nature.

SUMMARY.

Investigations during the year have shewn that the yields previously suggested as possible can be obtained and maintained at least over a period of 12 months.

Further it has been shewn, on a small scale, that the yields can be greatly increased by keeping a permanent supply of water round the roots of the palms.

Tapping up to the present has been maintained on about thirty 'stands'.

Results of analysis shew that the sugar content is variable, although an analysis of the contents over the whole area in tapping during 1924 should be sufficient to strike an average.

Sulphuric acid presents possibilities as a control for the alcohol manufacturer, although further experiments are necessary. Up to the present, no suitable substitute for lime has been discovered for the

preservation of juice intended for sugar manufacture. The excessive amount of lime required, except under very sterile conditions, makes it an objectionable preservative.

FUTURE INVESTIGATIONS.

The number of "stands" in tapping will be doubled during 1924 and a survey of the sugar contents of every spathe in the area will be made.

Further planting is in progress, involving different distances and other methods of propagation.

The results obtained by the digging of "catch" drains are so good that most of the area in tapping will be treated in a similar manner.

Further investigation will be carried out this year on methods of preservation of juice.

The Plant Physiologist also contemplates further investigations on the juice during the next twelve months.

Received for publication 20th March 1924.

A PRELIMINARY NOTE ON A NEW BARK DISEASE OF HEVEA.

By A. THOMPSON.

THE renewing bark of rubber trees has been damaged recently by a fungus growth, similar to one which formerly was observed to grow superficially on young bark at the corner of a tapping panel, where it formed a patch of white mycelium from 1—3 inches in diameter. This fungus was never observed to have penetrated the bark and disappeared normally by scaling of the bark.

At the end of 1922 and the beginning of 1923 several specimens of bark attacked by this fungus were received from various parts of the country, and in a few instances it was noticed that slight penetration had occurred.

During the last quarter of 1923 the fungus again became active, and specimens of the attacked bark showed that damage was being done, as in the majority of cases the fungus had penetrated to the wood, and caused the bark to rot.

SYMPTOMS.

One of the first signs of the present attack is a small fan of mycelium $\frac{1}{4}$ — $\frac{1}{2}$ an inch above the tapping cut, later forming a small plate of white mycelium, with a mycelial fan at the edges. A number of these plates may be formed, some at the corners and others in the centre, of the tapping cut. Later on some of these plates fuse together into several patches which may be from 6—8 inches in diameter. The disease can be seen from a considerable distance as these patches are conspicuous, being white at the edges where the fan-like mycelium creeps over the bark, and whitish grey in the centre where the bark is rotted.

Trees which were opened up for tapping on January 1st showed the disease after 3 weeks daily tapping. The disease, therefore, can become evident three weeks after infection and possibly sooner.

Little is known as yet about the method of infection, as inoculations of the fungus into the bark of health trees have so far produced no result.

CONTROL.

Up to the present the disease has proved amenable to treatment by putting the affected trees out of tapping and painting them with a 10—15% solution of Agrisol or Brunolinum plantarium, for two applications with 7 days interval between. All the trees in the affected area should be painted with a disinfectant *e.g.* 5% Izal, 10—15% Agrisol, Brunolinum or Brunolinum plantarium. As a precautionary

measure it would be advisable to sterilise the tapping knives of the coolies tapping the affected plots.

The disease is not as yet very serious, as only a few trees are attacked at the same time. The fungus appears to have been educated up to definite parasitism in a comparatively short space of time, and for fear of further developments it should be taken in hand at once.

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THE UTILISATION AND WASTE OF WOOD IN THE PREPARATION AND PACKING OF RAW RUBBER.

BY B. J. EATON.

THIS paper, which deals with the utilisation and waste of wood in the manufacture and packing of raw rubber has been written at the request of the Chief Secretary to Government F.M.S.

Before discussing the problem of the utilisation of wood in the preparation and packing of raw rubber the following extracts may be quoted from a publication on "Wood in the Federated Malay States, Its use, Misuse, and Future Provision" by G. E. S. Cubitt, Conservator of Forests, F.M.S. and S.S., published by the Government in 1920.

I. Waste :—(page 1). During the last twenty years more wood has been wasted in the Federated Malay States than has been used. Waste of such magnitude must always be a matter for regret, but it is a serious evil when combined, as it is here, with a shortage or bad distribution of supplies.

I. (vii) 8. *Waste Due to Deliberate (or Unanticipated) Destruction.* (d) *timber burnt by the planter*, (pages 2-3).—Assuming that the area of rubber plantations is one million acres (N. B. It is probably nearer $1\frac{1}{4}$ million acres, although not all of this was forest when the rubber was first planted, B. J. E.) and that each area held 50 tons of wood, we are confronted with the following facts (b) such a stock of wood at the present rates of consumption would have kept the country supplied for about twenty years with all the wood it required.

(c) An area of natural forest equal in quality and size to that burnt and similarly situated is sufficient, if properly managed, to supply for ever from one tenth to one fifth (probably more nearly one fifth) of the present demand for wood.

II. 9. *Consumption of Wood.*—It is estimated that in 1919 the consumption of wood by rubber factories amounted to 219,771 tons in the four States.

II. 10. *Item 4.* (pages 3-4) *These figures are arrived at as follows.*—One ton of wood for every 1085 lbs. of 106, tons of rubber exported; rate of consumption calculated from actual results on a rubber output of 5,075,576 lbs. by the Société Internationale de Plantations et de Finance. (Note :—It is not stated whether the whole

output is calculated as smoked sheet; presumably the figures supplied by the S. I. P. E. F. are for fuel consumed in the manufacture of smoked sheet B. J. E.).

III. 13. *Source of Supply* (page 6).—Rubber planters state that, with proper management, their plantations can be made to supply from thinnings and from naturally dead wood, all the domestic requirements of their labour force for fuel in addition to the timber required for smoking rubber, estimated to amount in all at 2 tons per head of the labour force. It should however be stated that such supplies are by no means always available, and that some planters are already finding difficulty and incurring heavy expenditure in purchasing fuel for their smoke houses.

IV. 26. (page 12). An advance was made in 1917 when, owing to the difficulty of preventing or diminishing the waste of timber on alienated land, the Government agreed:—

- (iv) that a condition might be inserted in titles permitting the Forest Department to extract timber from alienated land until the land was required for clearing.
- (vi) that Land and Forest officers should be instructed that, if possible, all first class timber should be removed from alienated land before it was burnt.
- (vii) that the Resident might, on the recommendation of the Conservator of Forests, prohibit, in particular cases, clearing and burning in excess of the area to be planted up, and might require a scheme of operations to be submitted before clearing was begun.
- (ix) that Residents might, in their discretion, charge a premium on land bearing some relation to its forest value.

VII. 32. (page 14). The rubber planter ruthlessly destroys the forest, making little or no use of the timber.

IX. (iii) page 18). The abandonment of rubber smoking and of the use of wooden cases for packing rubber.

49. It is generally admitted that the smoking of rubber is not really necessary and that it is done partly because "Fine Hard Para" from the Amazon is smoked, but chiefly to satisfy the prejudices of the London market. The United States Rubber Company, with an output in Sumatra of 1,000,000 lbs. a month, neither smokes its rubber or packs it in wooden cases, and what this and other companies do, can be done by all, if concerted action is taken. The use of bags for packing rubber would not effect a great saving, as most of the wooden cases now used are imported, but, if the large quantities of

wood (mostly rubber wood) now used for smoking were saved, part of it would no doubt be sold for domestic use and the demand on the forests be correspondingly decreased, probably with a lowering of price. If rubber is smoked, oil which gives good results might perhaps in some cases be used instead of wood.

(xi) (page 20). Planters to be made responsible for producing fuel for their own requirements.

57. Prominent planters assert that rubber plantations yield enough wood for domestic and factory use on their estates. It should therefore be declared that rubber planters have no claim on adequacy of supplies, either a wood-lot should be reserved on each estate, or quick-growing firewood trees should be planted. In the latter case the advice of the Forest Department would be at the disposal of the planters.

(xii) page 20). *The Prevention of Unnecessary Destruction.*

58. This refers particularly to destruction by the rubber planters, which the present rules are inadequate to prevent. It should be impressed on planters that timber has a value, and it is suggested that this might be done in one or more of the following ways:—

- (a) the timber should be paid for;
- (b) the planter should be compelled to extract from the estate and deliver to Government, on terms to be agreed upon, such timber as Government may demand;
- (c) the grant of land should not convey any absolute right to the timber on the land;
- (d) a premium should be paid for the timber, recoverable at fixed rates for any timber utilised and not wasted.

There is some difference of opinion as to the extent to which (b) is possible. Planters on the one hand complain that, though they offer timber free to anyone who will take it away, few will come forward to do so; timber cutters on the other hand assert that the conditions imposed by planters to prevent damage to the estate render the removal of timber almost impracticable.

Planters say that, when forest is felled and burnt, the greater part of the good timber escapes serious damage and can then be extracted, but timber cutters generally object to work in an open plantation on account of the heat, and complain that charred timber damages their tools and is harder to work than green timber. If these difficulties can be overcome, it should at least be possible to arrange

for the more durable timber to be stored for future use and a useful stock of seasoned material accumulated.

To sum up, the Conservator of Forests issues a strong warning in connection with the present rate of destruction of timber, which is in danger of exhaustion, and urges the vital necessity of providing for the distant future.

UTILISATION OF WOOD IN THE PREPARATION AND EXPORT OF RAW RUBBER.

Wood is at present used in connection with the manufacture and export of rubber chiefly for two purposes :—

- (a) for the manufacture of packing cases for export of all grades of rubber;
- (b) as a fuel for the drying and smoking of rubber chiefly in the manufacture of smoked sheet.

The greater proportion of the wood used for packing cases is imported into the country, suitably cut and ready for the manufacture of packing cases, while the wood used as fuel for smoke houses is entirely from local sources. In addition a certain amount of wood is used either direct or after conversion to charcoal, as a source of fuel for the prime mover in the factory (Suction gas engines etc.). As is well known, the packing cases at present in use are those known as Momi cases imported from Japan and the well known three-ply Venesta or similar cases, manufactured chiefly in Europe. Tea chests are also used to a small extent. In Singapore, considerable quantities of rubber are packed in boxes, larger than the average sized Momi or Venesta cases, and made from local wood such as meranti. No figures are however available as to the amount of local wood consumed in this way.

PACKING CASES.

As far as the writer is aware, no estimate has been prepared or is available as to the amount of wood imported in the form of Momi cases or Venesta cases, but a fair approximation can probably be arrived at on the basis of the amounts of rubber exported annually from Malaya, from the average weight of wood in a packing case and the average weight of rubber contained in such cases.

In former years, Venesta cases were used almost solely on all estates, but during and since the war, a greater number of Momi cases have been used.

The following basis has been used for the calculation of the amount of wood utilised for packing cases :—

(1) Year.	(2) Export of Rubber from Malaya. (Tons.)	(3) Number of Venesta cases and weight of wood in cases.			(4) Number of Momi cases and weight of wood in cases.		
		Smoked Sheet.		Crepe.	Smoked Sheet.		Crepe.
		Number.	Weight of wood (Tons.)		Number.	Weight of wood (Tons.)	
1906	400	4,000	20	5,600	4,400	40	6,000
1907	1,000	10,000	60	14,000	11,000	100	15,000
1908	1,500	15,000	90	21,000	16,500	150	22,500
1909	3,000	30,000	180	42,000	33,000	300	42,000
1910	7,000	70,000	420	98,000	77,000	700	105,000
1911	11,200	112,000	670	156,800	123,200	1,120	168,000
1912	19,200	192,000	1,150	268,800	211,200	1,920	288,000
1913	29,500	295,000	1,770	403,000	324,500	2,950	442,500
1914	43,200	432,000	2,590	604,800	475,200	4,320	648,000
1915	68,500	685,000	4,110	959,000	753,500	6,850	9,130
1916	96,800	968,000	5,810	1,335,200	1,064,800	9,680	13,570
1917	127,000	1,270,000	7,620	1,778,000	1,397,000	12,700	16,930
1918	130,200	1,302,000	7,810	1,822,800	1,432,200	13,020	17,360
1919	167,100	1,671,000	9,920	2,355,600	1,819,400	16,540	22,050
1920	162,000	1,620,000	9,720	2,268,000	1,782,000	16,200	21,600
1921	151,000	1,510,000	9,060	2,114,000	1,661,000	15,100	20,130
1922	212,700	2,127,000	12,760	2,977,800	2,339,700	21,270	28,360

Venesta cases (21 ins.)
Momi cases (19 ")
Weight of wood per case ... 13 lbs.
... 20 "
Amount of smoked sheet packed in Venesta cases ... 22½ lbs. (Average)
" crepe rubber " 16½ "
" smoked sheet " 200 "
" crepe rubber " 150 "

In the above table, the number of cases and amount of wood used for packing cases has been calculated on the assumption in column (3) that Venesta cases only are used and in column (4) that Momi cases only are used. The weight of wood is possibly not of great importance, but the large saving in cost by using cases other than wood, can be easily determined by the figures of cost given later.

No information is available as to the proportion of smoked sheet to crepe which is exported. Another factor, which affects the figures although not to any marked extent, is the amount of blanket or thick crepe, which is manufactured on some estates from lower grade rubbers, (such as tree scrap, bark scrap and earth scrap rubber of mixtures of these, known as compo grades) and also manufactured to a fair extent from native sheet in the large crepeing factories in Singapore. Blanket or thick crepe occupies a smaller space per unit weight of rubber than thin crepe and is very similar in bulk to sheet in respect of packing space required. One other factor which has also reduced the number of packing cases used during and since the war, is the practice of using small presses in the estate factory, in order to compress more rubber into the cases.

Local wood, used in the manufacture of packing cases in Singapore for export of rubber, is included in the above estimate. These packing cases are usually constructed of thicker and heavier wood, but this is compensated to some extent by the larger size of the cases.

It may be remarked here that these cases are used chiefly for packing rubber, which is received in Singapore from the Peninsula, packed in canvas bags or bales made from locally manufactured or imported menkuang or grass matting. A portion of the native sheet, which is creped in Singapore factories, is also packed in boxes made locally from local wood. This includes a lot of crude rubber imported from Sumatra and milled and repacked for export in Singapore. Although canvas bags and matting bales are used for local transport purposes in shipping rubber to Singapore, little or no rubber has been exported outside Malaya in such packing until recently. The packing of rubber for export in bales made of good lower grade rubber has also been adopted up to the present only in the case of experimental shipments.

SUBSTITUTION OF NON-WOOD PACKING.

The primary objection to baling rubber in casings composed of soft materials is that the rubber becomes "massed" so that it is difficult to separate individual sheets or pieces of crepe, when the bales are opened.

This "massing" of the rubber is due almost entirely to the fact that when the rubber is shipped, the lower bales in the hold must of necessity be compressed by the bales above. In the case of wooden packages, this does not occur to the same extent, since the rubber in each box is not affected by the weight of other boxes, owing to the rigidity of the cases.

Smoked sheet packed in cases under pressure must however arrive home in a similar massed condition.

In the case of non-waterproof packing materials, e.g. matting, canvas, lower grade crepe rubber (which may be slightly porous, owing to the rubber not being satisfactorily machined to eliminate small pin holes) jute sacking or other materials, there would be also greater probability of the wetting of such rubber by transport during wet weather. Provided however that the bales were not allowed to lie in the open, this could be avoided by the use of some covering, during local transport in bullock carts, motor lorry or other means of conveyance. This disadvantage also applies to a lesser extent to rubber packed in wooden cases, which frequently become wet after leaving the estate, causing the development of moulds and spot disease in the rubber. It need scarcely be mentioned also that rubber should not be packed in materials such as untreated jute sacking in direct contact with the rubber, since it is more difficult to remove the fibres of such packing from the rubber subsequently than to remove chips of wood or sawdust derived from broken boxes.

(Note :—Specially treated jute sacking is however being used at the present time for baling rubber, exported to America).

The use of a lower grade rubber packing inside ordinary sacking would however prevent contamination of the contained rubber. One advantage of the raw rubber packing is that the packing material itself can be used in the manufactory after subsequent washing etc. so that the only "waste" would be the baling wire or cord.

It should not be necessary to emphasise that the massing of the rubber, which occurs by baling in non-rigid packings, does not in any way deteriorate the rubber, and that objections raised on this score are, in the writer's opinion, not worth consideration. In fact the writer is prepared to state that such rubber is probably preferable from a storage point of view, since the deterioration which usually occurs in raw rubber is due largely to surface effects and in a block or mass of rubber the surface per unit weight is reduced.

Types or Grades of Rubber in relation to packing.—The type of packing case may also be considered in relation to the type of rubber prepared. Types of rubber which are suitable particularly to non-rigid packing cases are "block" rubber and "slab" rubber. In the case of these types of rubber the question of "massing" is not involved.

Block rubber consists of thin crepe dried in vacuum or hot air driers and subsequently pressed in hydraulic presses. Slab rubber can be creped and prepared in this way and is of excellent quality.

Slab rubber prepared on a large scale on the H. A. P. M. (Holland-American Rubber Company) estates in Sumatra and shipped in the slab form has been exported several years to America in treated jute sacking.

In concluding this section on the use of materials, other than wood, for packing cases, the following details are of interest in respect of (a) lower grade rubber packing similar to the Gjorup packing case, (b) Malayan Menkuang matting, for which a bale has been designed and patented, (c) tobacco bale matting (this matting is also used by at least one other estate for local transport to Singapore), (d) jute sacking, (e) canvas bales.

Rubber Packing.—Provided the rubber used for packing is well knitted together on the machine to render it impermeable to dust and small particles, crepe rubber (a good lower grade) is quite suitable as a packing material.

Special cases of this material have been designed and patented by Gjorup Bros. in Malaya in 1921.

It is not a difficult matter for planters to make their own cases from lower grade crepes.

In the case of this material the rubber constituting the casing can, after washing, be used by the manufacturer for second quality articles.

In a pamphlet on the subject the "inventors" shew that the cases can be made from about 10—12 lbs. of lower grade crepe rubber. The percentage of suitable lower grade to "first latex" rubber made on estates is sufficient to provide the amount required on any estate for packing purposes. Such cases measuring $19 \times 19 \times 24$ inches will contain about 225 lbs. smoked sheet rubber or 75 lbs. of thin crepe compared with 200 lbs. and 150 lbs. respectively for a Momi case; the cost of the packing is considerably less, even if the rubber used for the cases is assumed to have no value. The reduction in cost amounts to from \$20/- to \$35/- per shipping ton.

(b) and (c). Menkuang palm or similar matting used for the baling of tobacco in the Netherlands East Indies is eminently suitable as a packing material for rubber. A packing case of this material has been designed and patented in Malaya. These cases cost about half the price of locally made Momi cases and one third that of imported Momi cases.

Cases can also be made by planters in the estate factory. Experiments have also been carried out in Java by planters and by the Rubber Proefstation at Buitenzorg, Java on the packing and export of rubber in bales made of matting of this type, which is also used for the baling and export of tobacco.

Many local rubber dealers in Malaya also bale their rubber in similar matting, which is imported in sheets from China. This material is probably one of the best and cheapest for baling of rubber for export to Europe and America.

(d) *Jute or Gunny bag packing.*—Jute or gunny sacking is not very suitable as a packing material, unless previously treated on one side, to prevent the loose fibres from adhering to the rubber.

Slab rubber and Hopkinson Sprayed rubber is however exported from Sumatra in jute sacking after suitable treatment of the sacking.

One of the largest manufacturing firms in America, which buys large quantities of rubber in Singapore, also exports all its rubber from Singapore in jute sacking (old rice bags) which are coated on one side with a preparation of starch and glue and dusted with talc to prevent adhesion of the fibre to the rubber contents of the bales.

The fact that two of the largest rubber manufacturers in America have adopted this packing for rubber exported from Malaya and Sumatra should be sufficient to indicate that the packing is suitable. The cost of the packing material, including the sewing of the bales is less than half the cost of wooden cases.

"First Latex" crepe rubber is also transported to Singapore by the Kajang Central Rubber Factory (a co-operative factory) in gunny bags. The bale of crepe is first wrapped with 4 lbs. of crepe of the same grade. One broker sells the contents, including the crepe wrapping, while another deducts 6 cts. per lb. for the crepe used as wrapping. The time taken to pack rubber in wooden cases and in bags is stated to be the same and therefore the cost in both cases is the same.

Mr. Hands the manager of the factory has kindly supplied the following figures:—

Pre War.	Wt. in lbs.	Rubber content (lbs.)		Cost of Case.	Total Cost.
		No. 1 crepe.	Lower grade crepe.		
Venesta Cases ...	13	165	170	\$1.37	1.40½
Momi case ...	20	150	140	0.56	0.66
PRESENT DAY.					
Venesta Case ...	13	165	170	1.65	1.70
Momi case (secondhand)	20	150	140	0.85	1.04
Momi case (new) ...	20	150	140	1.11	1.28
Tea case ...	20	140	140	1.25	1.37
Jelutong case ...	19½	140	140	0.82	1.00½
Gunny bags ...	3	150	140	0.15	0.15½

In each case the size of the cases is $24 \times 19 \times 19$ inches and the contents 5 cubic feet. The difference between the cost of cases and total costs includes "making up" in the case of the Venestas, strapping, nails and "making up" in the case of the Momis and additional wire and staples in the case of the secondhand Momis and other wooden cases.

The additional cost in the case of the gunny sacks is only a $\frac{1}{2}$ cent for string.

(e) *Canvas Bales*.—Canvas bales have been designed and patented by a Japanese firm in Malaya and are used by some estates in Malaya for local transport to Singapore. The empty bags are returned to the estate and used many times. The initial cost is high but the packing is economical for local transport, in view of the fact that the cases are used many times.

This method of packing may not be suitable for export outside Malaya as the empty bales will probably not fetch much if sold and the cost and trouble of returning them will probably be too great.

THE USE OF WOOD AS FUEL IN THE PREPARATION OF RUBBER.

Almost all the wood used on estates in the preparation of rubber is consumed in the smoking process for the manufacture of smoked sheet.

The use of wood as fuel in the preparation of rubber may be considered from the following points of view:—

- (a) Intrinsic quality of the rubber.
- (b) Producer's point of view.
- (c) Market or buyer's point of view.
- (d) Manufacturer's requirements.
- (e) Elimination of fuel in the preparation of rubber.
- (f) Substitution of fuels other than wood.
- (g) Preparation of other types of raw rubber.

It will be evident that, in any discussion of these various view points, there must inevitably be a certain amount of overlapping.

The only point of view which should really require discussion is the intrinsic quality of the rubber, which should represent the manufacturers requirements.

ORIGIN OF SMOKING PROCESS FOR PLANTATION RUBBER.

Before discussing the problem under the various headings indicated above, it is probably desirable, even at this stage of the plantation industry, to refer to the origin of the smoking process as employed for the preparation of smoked sheet, and the reason for its retention.

Although the writer has no definite information as to (a) whether the smoking of plantation rubber was commenced first in Ceylon or Malaya (b) the originator of smoked sheet (c) the approximate date on which smoked sheet was first placed on the market, (it does not appear worth while at the moment to search for this information) it was commenced very early in the history of the plantation rubber industry. It is practically certain however, from the literature on the subject and the opinions expressed, that smoking of plantation rubber was first practised as an imitation of the Amazonian process of smoking, used in the preparation of the highest grade of wild rubber viz. Fine Hard Para. In the early days of the plantation industry, there was, as in any new form of preparation, a prejudice in favour of this grade (Fine Hard Para) which was well known to the manufacturer in respect of its constancy and other qualities during vulcanisation.

This prejudice still exists, although only to a small extent at the present time, and the premier grade of wild rubber still realises a higher price than the highest grade of the plantation product after the moisture content and loss on washing are taken into account. In at least one manufactory in England in 1920 visited by the writer, only Fine Hard Para was still being used, while in others it is still said to be used exclusively for certain classes of goods.

In the early days of the industry also, it was considered that the South American smoking process conferred special qualities on the rubber, in virtue of the type of fuel used, which was assumed to be chiefly the fruits or nuts of the palm, *Attalea Excelsa*. The plantation method, in which sheet rubber was prepared by coagulation in the usual way with acetic acid and subsequently smoked, as in present practice, was considered also, in the early days, to have failed as a successful imitation of the South American process, as the smoke was supposed to be absorbed superficially only.

Various machines were designed and patented for preparing rubber on a principle similar to that used for the preparation of Fine Hard Para but constructed on a scale suitable for dealing with the large quantities of latex collected daily on estates. Hitherto however none of these have been adopted. Even as recently as 1921, Sir Henry Wickham, the "father" of the plantation rubber industry, has patented a new machine (which is stated to be an improvement on his former machine) for preparing rubber by the South American process. While there may have been accidentally or incidentally some special merit in the process, due either to the method or the fuel, it should be fairly obvious that the method was adopted in the earliest days by the seringeiros (native collectors and tappers of South America) because it happened to offer a convenient method of preparation suitable to forest or jungle conditions and within the capabilities of the native collectors and not on account of any intrinsic value as a process.

While the writer and other research workers are probably still prepared to admit the superiority of Fine Hard Para in one or possibly more than one respect, this superiority has no connection with the smoking process nor with the fuel employed.

For reasons similar to those for which the native collectors adopted and retained their process for the preparation of Fine Hard Para, estate managers and owners have retained the smoking of plantation rubber viz. on account of its convenience in certain directions.

Thus the smoking of plantation sheet, adopted in the first instance as an imitation of the method of preparing Fine Hard Para, on account of the fact that it was thought to confer superior qualities on the rubber, has been retained mainly for other reasons and it is in this connection that arguments against its continuation will have to be chiefly directed.

EFFECT ON THE INTRINSIC QUALITY OF RUBBER.

The researches of the writer and other workers have shown that the smoking of rubber, as practised on estates, confers no special or superior qualities on rubber. In fact, as far as quality, judged on rate of vulcanisation, is concerned, the effect of the smoking may be described as detrimental, although in the smoking process, as the writer has shown, two factors are concerned viz. heat and smoke. The effect of the former, within the normal limits of smoke house conditions is to accelerate the rate of vulcanisation of the rubber, without effecting its physical properties.

The effect of the normal process of smoking therefore results from a balance of two factors operating in opposite directions and, for commercial purposes or as far as the value of the rubber to the manufacture is concerned, smoked sheet is probably in most cases neither superior nor inferior to unsmoked sheet. From the point of view of quality therefore the smoking process in the case of sheet could be abandoned.

Formerly thin crepe was smoked to some extent, but chiefly before the introduction of sodium bisulphite, which resulted in the pale crepe at present marketed as one of the first grades of plantation rubber.

Smoked crepe however is no longer prepared; one reason for its abandonment was probably the fact that many defects of appearance in crepe rubber can be obscured easily by smoking and the buyer therefore was unable to distinguish between different grades. The writer has shown that smoking has little or no effect on crepe rubber.

The reasons for the retention of the smoking process in the case of sheet do not exist in the case of thin crepe, so that the smoking of crepe rubber, which has already been abandoned, need not be considered further.

In the case of "slab" rubber the writer has shown that a marked reduction in the rate of cure occurs, while no superior qualities are conferred on this type of rubber, by smoke-drying. Smoking therefore is not essential, in fact it should be avoided, in the preparation of this type of rubber.

It can therefore be concluded that, in the preparation of all grades of rubber, smoking is not advantageous as far as the intrinsic quality of the rubber is concerned.

PRODUCER'S POINT OF VIEW.

The type of rubber prepared by the producer or grower must be considered from the point of view (a) Economy in preparation, (b) Selling value as judged by the buyers or brokers (c) Manufacturers' requirements, which should be high intrinsic quality, irrespective of appearance.

It has already been indicated that, although smoked sheet was prepared first as an imitation of the Amazonian process for the preparation of Fine Hard Para, it was soon found to have advantages over air-dried sheet in respect of rapidity of drying and comparative freedom from moulds and bacteria. The antiseptic properties of the smoke prevent mould growth to a considerable extent, while considerable saving in drying space and time of drying is effected, in comparison with the preparation of air-dried sheet.

By the use of suitable antiseptics however and drying in hot-air drying rooms by means of special stoves, resulting in economy of fuel, a good imitation smoked sheet can be prepared. On a new estate for many years, plenty of wood is available from the jungle, which has been felled for planting purposes and which must be cleared in order to reduce or eliminate diseases, or from the thinning out of too closely-planted rubber trees, so that, in such cases, the cost of fuel for smoking has been negligible. Further in the preparation of sheet rubber the cost of equipping a factory is considerably less than for the preparation of crepe rubber, since small power or hand machines can be used for rolling the coagulum.

On the other hand the manufacture of "first latex" pale crepe, from latex to which sodium bisulphite has been added to produce a pale rubber, is more fool proof than the manufacture of smoked sheet, as long as rubber is sold largely on appearance. Smoked sheet develops certain defects, which, while they have no effect on the intrinsic quality of the rubber, affect its market value as judged by the buyers.

As long as fuel is available therefore on the estate, the cost of manufacture of smoked sheet should be less than the cost of preparation of pale crepe. If and when fuel for smoking has to be purchased, the preparation of thin pale crepe will probably be more economical.

The writer and others have shown that, except for special purposes, sheet rubber is generally superior in quality to thin crepe and would be used by manufacturers for all purposes when colour of the finished article is not the chief desideratum.

Thus smoked or unsmoked sheet rubber or some other type of preparation is to be preferred from the manufacturer's point of view to thin pale crepe, which is normally air-dried and requires no fuel, except for power purposes during machining.

As far as the producer is concerned therefore, unless the industry in the principal producing countries become so organised that all producers can be persuaded or compelled to prepare rubber of a particular type, it is doubtful whether anything less than high cost of wood will effect any alteration in the type of rubber produced.

Any Government restriction on the method of manufacture in a particular country would probably be detrimental to the country concerned.

It is hoped to indicate however that economies can be effected by the producer and that one or more new types of rubber can be substituted for smoked sheet with advantage to the manufacturer in respect of quality.

MARKET OR BUYER'S POINT OF VIEW.

The present methods of buying and selling raw rubber may be described as almost entirely artificial, being based mainly on appearance and having no real relationship to intrinsic quality. This is due principally to the rapid rate of growth of the plantation rubber industry, with which scientific research on the raw product was unable at first to keep pace. At the present time however our knowledge of the qualities of the raw material and the causes of real or intrinsic defects is more advanced and we know that, to a considerable extent, appearance, as a criterion of quality, is misleading, although generally a good appearance indicates careful preparation and supervision in the estate factory.

The market for smoked sheet however is well established and the effect of removing this grade from the market, except by action by the whole of the plantation industry requires careful consideration.

Restriction in the manufacture of smoked sheet must be brought about by forcing on the producer a realisation of the necessity for saving fuel and on the market the fact that other types of rubber equal or superior to smoked sheet can be manufactured. If the industry were well organised especially at a time, such as the present, economies in production could be effected by forcing on the market another type of rubber and such action is justifiable, provided the substituted product can be shown to be equivalent or superior in quality.

If the plantation industry were organised the buyer need receive little or no consideration.

MANUFACTURERS' REQUIREMENTS.

It may be safely assumed that the manufacturer is concerned primarily with the cost of the raw rubber and its intrinsic quality. Only for special purposes is the colour and appearance of the raw rubber of primary importance and the demand for such purposes is met by the preparation of thin pale crepe, which requires normally no consumption of fuel for drying, while for power purposes, oil fuel, charcoal or coal can be employed.

It has already been stated that in the case of the large estates belonging to the United States Rubber Coy. in Sumatra, a particular type of rubber, which at present cannot be sold on the open market, is prepared and shipped to the factories of this company in America. The Company using the raw rubber has doubtless recognised its value and is not concerned with appearance.

Another large Company in Italy is also using "slab" rubber, prepared on its own estates in Malaya.

The preparation of smoked sheet is therefore not essential to the manufacturer. If it were possible therefore to establish direct buying and selling between rubber manufacturers and producers of raw rubber, type of rubber other than smoked sheet could be marketed.

ELIMINATION OF FUEL IN THE PREPARATION OF RAW RUBBER.

It is doubtful whether the elimination of fuel entirely in the preparation of raw rubber is advisable. The only satisfactory method would be the preparation of thin pale crepe, which does not require artificial drying, or the conversion of such thin crepe, after natural drying, into a blanket or thick crepe.

In view of the generally somewhat inferior quality of thin pale crepe and its slower rate of vulcanisation, the writer is of opinion that the preparation of this grade only (either as thin crepe or as blanket crepe, after drying in the form of thin crepe) is not advisable.

The preparation of a thick blanket crepe direct from latex will be discussed later. In the preparation of certain types of rubber however, fuels other than wood can be employed.

SUBSTITUTION OF FUELS OTHER THAN WOOD.

In the preparation of smoked sheet the elimination of wood fuel is not possible, since other fuels e.g. oil, coal or charcoal will not produce a similar product. Other waste materials such as lalang or other grass, bukar (secondary jungle) or other vegetable or cellulose material is not available in sufficient quality and would also not produce a product similar to smoked sheet prepared by the burning of wood.

An equally good imitation smoked sheet could however be prepared by "doping" latex or freshly machined sheet with creosote products and then subsequently drying the sheet in hot air chambers or warm rooms in which various kinds of fuels other than wood could be burnt in special furnaces or ovens, so that only the heat from the combustion of such fuels acts on the rubber, the products of combustion of the fuel being led outside the heating chamber.

With properly constructed drying rooms and furnaces this would undoubtedly result in economy of fuel.

It has also been shown by the researches carried out at the Department of Agriculture that unsmoked sheet is equal in quality to

smoked sheet and in some respects may be superior, especially when dried at a slightly elevated temperature.

Unfortunately unsmoked sheet, unless dried at an elevated temperature, is very liable to attack during drying by "spot" disease caused by fungi and bacteria; experiments are still required to ascertain whether unsmoked sheet dried artificially will develop "spot" disease more rapidly than smoked sheet.

Unless antiseptics are added to the latex this would probably occur. If thick blanket crepe were prepared direct from latex this could be dried by heat derived from fuels other than wood and would be an excellent substitute for smoked sheet. Coal or oil and various waste products in certain districts could be used as fuel in special furnaces.

In addition, if acetic acid and various other products obtained by wood distillation were manufactured locally, the resultant charcoal could also be used as fuel in special furnaces in the drying rooms.

PREPARATION OF OTHER TYPES OF RUBBER.

Thin Pale Crepe.—It has already been indicated that thin pale crepe rubber is of value to the manufacturer for special purposes and that, although this type of rubber can be prepared without the use of fuel, its preparation as the sole grade of "first latex" rubber is not desirable, since its somewhat inferior quality and slower curing properties are disadvantageous.

(*Note.*—No investigations have yet been published on the effect of the addition of accelerators on the quality of this grade of rubber. In view of the increasing use of artificial accelerators, and provided their addition to this grade of rubber increases the tensile strength of the rubber to render it equivalent to other grades similarly treated, the preparation of thin pale crepe could be recommended as the sole first grade rubber).

At the present stage of our knowledge however, the manufacture of thin pale crepe, as the only first grade product, cannot be recommended.

Blanket Crepe.—Blanket crepe prepared from dried thin pale crepe is similar in quality to thin pale crepe, although owing to the smaller surface area per unit weight of rubber, it is better from the point of view of packing and subsequent storage. Its preparation also requires extra machinery.

Block rubber made from thin crepe is superior in respect of packing space, transport and surface area per unit weight, but extra time and machinery are necessary for its manufacture, while its quality is similar to that of thin crepe.

Blanket crepe made direct from latex, by being subjected to less machining and dried in hot-air chambers or artificially heated drying rooms should prove an excellent substitute for smoked sheet. This type

of rubber can be dried artificially by the use of any type of fuel, provided the products of combustion of the fuel are not allowed to come into contact with the rubber. Special artificial drying rooms could be used which would also result in economy of fuel.

Slab Rubber.—The type of rubber, which was originated by the Department of Agriculture, is an excellent grade to substitute for smoked sheet and its use would probably be more general if raw rubber were not bought and sold on the market chiefly by appearance.

Although this type of rubber can be prepared without the aid of fuel or artificial drying, it is preferable in some respects to mature and partially dry it at an elevated temperature.

Our experiments have shown that the drying period, especially at a temperature equivalent to that normally employed in smoke houses, viz. about 120° Fah., need not exceed six days in the case of large slabs and this represents a considerable economy compared with the normal period of drying for smoked sheet. Further, any type of fuel to produce the necessary heat, may be used, since it is preferable that the products of combustion should not come into contact with the rubber.

When shipped in the form of "slab" this type of rubber contains from 10 to 20 per cent of moisture according to the method of preparation and drying and has to be converted into crepe by the manufacturer before it can be dried completely for vulcanisation purposes.

As has been stated previously, this type of rubber has been prepared and shipped by the H. A. P. M. in Sumatra for several years. The coagulum is machined roughly and is then kiln-dried to produce a dry outer skin and shipped in 200 lbs. bales enclosed in specially treated jute sacking. The rubber, which contains about 12 per cent of moisture, is sent to the Company's own factories in America and not sold on the open market.

It is stated that "it would not be possible to sell this rubber on the open market, since, apart from other considerations, few manufacturers have sufficient facilities for washing and ultimate drying "and that" it is doubtful whether the process shows any economy of fuel consumption, as wood is used as fuel both for power purposes and for working the kilns."

The preparation of this type of rubber on a large scale by a Company in Malaya has shown that it can be "matured" in a much shorter time than is required for the complete drying of smoked sheet, under similar conditions. Owing to the fact that a latex of high concentration can be used, slabs can be prepared from a gallon of latex containing 2.5 to 3 lbs. of dry rubber, which effect an economy in space in the drying house.

This type of rubber is also prepared on estates in Malaya belonging to another rubber manufacturing Company and shipped to the manufactory in Italy.

Economy in freight is also effected since, owing to the high rubber content of the slabs, a larger amount of rubber can be packed in unit space, in spite of the moisture content.

The type of rubber has also been prepared and, after maturation, creped on a large scale by a company in Malaya, the crepe being subsequently air-dried in an ordinary crepe drying house.

In spite of the greater power required to machine the hard matured coagulum, the writer is informed that the cost of crepeing is considerably less than the cost of making "first latex" pale crepe since there is no necessity to "finish" the rubber to the same extent and less crepeing is required, so that much more rubber can be machined in the same time.

As previously indicated, this type of rubber can also be converted into thin crepe and be subsequently hot-air or vacuum dried and blocked for export.

The preparation of this rubber would result in considerable economy in estate factories and in the cost of packing, transport and fuel.

Whole Rubber.—Comparatively recently, apparatus has been patented for the desiccation of latex by spraying (impinging) latex in the form of a jet on a rapidly rotating disc in a hot-air chamber. Oil fuel is used in the furnaces for heating the chambers. The process is known as Hopkinson's or the Spray process and has been patented by the General Rubber Company, U.S.A.

It is not necessary to describe in detail in this paper, the method of procedure, but it might be stated that several plants are at work on the Company's plantations in Sumatra and arrangements will probably be made to introduce the process into Malaya.

It has been known for some years that rubber prepared by the evaporation of latex has excellent tensile qualities and a comparatively rapid rate of vulcanisation but no apparatus has been available until recently for the satisfactory preparation of such a type of rubber on a large scale. In the manufacture of this type of rubber about 60 to 65 per cent. of water has to be evaporated from latex and no figures are available as to the economics of the process in respect of the fuel required for the evaporation of this water. The process however lends itself to high efficiency in respect of fuel economy. Fuel other than wood can also be used as a source of heat. In Sumatra, oil fuel is burnt in special stoves or furnaces. This rubber, like slab rubber, can also, after being pressed into blocks, be shipped in bales of non-rigid packing material such as treated jute sacking, as is done at present in Sumatra.

SUMMARY.

Packing Cases.—Non-rigid casing material can be used for the baling or packing of rubber, in lieu of wood, without affecting the

quality of the rubber, such as canvas, matting made from local raw materials, jute sacking suitably lined or treated in order to protect the rubber from the fibre of the jute and lower grade crepe rubber used alone or as a lining to other packing. Such packing material is especially suitable for slab rubber or blocked "whole" rubber prepared by the desiccation of latex.

The export of rubber from Malaya and Sumatra in bales of treated jute sacking by two of the largest rubber manufacturing firms in America and trials in Malaya and Java with tobacco matting bales or similar material indicate that these materials can be substituted for wood cases with satisfactory results and at considerably less cost to the producer.

An organised rubber industry, in view of the necessity for lower-costs of production, should insist on such packing, irrespective of the foibles of the buyer.

Fuel for Drying and Smoking Rubber.—The substitution of fuels other than wood, such as coal, oil or charcoal can be made, if certain types of rubber are manufactured e.g. Slab rubber, whole, rubber, blanket crepe or "smoked sheet," sheet made by treating unsmoked sheet or latex with creosote etc., and subsequent drying in hot air. Economy in the use of wood or other fuel can also be effected in such cases by the use of special furnaces if wood is available and is found to be cheaper than other fuels.

Elimination of fuel for drying rubber can also be effected by the manufacture of thin crepe or the subsequent conversion of dry thin crepe into blanket crepe. This however may not be desirable on account of the poorer quality of thin crepe compared with sheet and other types of rubber.

Slab rubber can also be cut into thin slices and dried in hot air driers and then pressed into blocks or, after the maturation period, it can be converted into ordinary crepe and air-dried at normal temperature. Large consignments of "slab" crepe have been made and sent to America by a group of estates in Malaya.

CONCLUSION.

The question of the baling of rubber for export is a matter which could probably be dealt with most effectively by an organisation such as the Rubber Growers' Association, which controls the largest production of plantation rubber, apart from small holdings. The small holders do not affect the situation, since they sell their product chiefly to local dealers and most of this rubber is already packed in non-wooden cases. The rubber manufacturer would not be affected adversely and the market buyers need not be considered.

Such a change in packing cases would save the producers large sums annually, but the change can only be effected by some fairly powerful organisation.

(Note :—The saving effected by the substitution of gunny bags for Venesta and Momi cases as used in the Central Factory, Kajang, can be easily calculated from the table giving the rubber exports from Malaya from 1906-1922 and from the figures quoted for relative costs at the Central Factory, Kajang.)

With regard to the preparation of other types of rubber, in order to eliminate the use of wood fuel or to reduce the present wastage, this also appears to be a problem to be taken up by a powerful organisation.

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COLOMBIAN PITA FIBRE.

By B. BUNTING.

IN 1919, an undertaking called the Arghan Company, Ltd., was formed with the object of organising an expedition to investigate and obtain supplies of a fibre plant for cultivation in the East. The plants were introduced into this country under the name of "Arghan," called after the company. It has not been found possible to determine the botanical name of these plants, and this cannot be done with certainty until the plants reach the flowering stage.

At a later date, another Syndicate, known as Pitales, Ltd., commenced to distribute Colombian Pita fibre plants in this country, thought to be a similar plant to that introduced by the Arghan Company.

A considerable amount of interest has been taken in these recent introductions. The last named plant occurs wild in the tropical parts of South America and is known by the vernacular name of "Pita." The term Pita is a Spanish word applied generally to various fibre-yielding plants and also to the fibres obtained from them. The botanical identity of the plant remained obscure for some considerable time and was thought to be *Ananas macrodontes*, E. Morr., but recent investigations have shown that the plant in question is *Bromelia Magdalenae*, C. H. Wright.*

A full description of the Colombian pita fibre plant has been given by Mr. M. T. Dawe, F.L.S., in "Tropical Life," December 1920 and January 1921, and the information contained in the above articles has been utilised extensively in compiling this paper.

DESCRIPTION OF PLANT.

The Colombian Pita plant resembles the pineapple, in fact, it might be described appropriately as a giant pineapple plant. A single mature plant carries from 20 to 40 leaves, which attain a length of 10 feet or more, and are about 4 inches broad in the centre. They are convolute towards the base, otherwise flat, and taper towards the apex. The margins are toothed: from the middle to the base the teeth turn downwards, in the upper half upwards.

The flowers are produced in pineapple-like heads, which are borne singly, sometimes, however, in groups of two or three. The heads are about 9 inches long and $4\frac{1}{2}$ inches broad, but differ from the ordinary pineapple inflorescences in having conspicuous rose-coloured bracts. The flowers are blue and fugitive.

Fruiting is irregular, but since the plant throws out stolons underground, giving rise to suckers, the latter can be used for propagation. So strong is its reproduction by this method and the growth of

* Kew Bulletin No. 7, 1923 p. 267.

the plant so vigorous, that it takes entire possession of the land to the exclusion of other forms of undergrowth, excepting trees and palms which afford the shade necessary for its growth. It therefore forms impenetrable masses covering extensive areas, which resemble plantations to such an extent that the Colombians call them "pitaes."

OCCURRENCE OF PITALES.

Pita is a shade loving plant and is usually found as undergrowth in the shade of the tropical forests. The Chiriguana forest, a mixture of trees and palms, is famed throughout Colombia for its extensive "pitaes." The density, in which the pita plant grows to the exclusion of all other plants, may be indicated by the fact that it is impossible to penetrate these forests except by hacking a way through by a machete or cutlass (parang). The plant flourishes in light sandy soil; it will not grow on wet land or land subject to frequent inundation. Pita lands are therefore generally healthy and the forests are usually well-watered by clear flowing streams from the Cordilleras. The plant will not thrive in the open in the tropical regions, and where the plant has been observed in the open it has been, in every case, in the sub-tropical parts of the country.

CULTIVATION OF PITA.

As far as is known, the Colombian Pita plant has not been cultivated on a commercial scale, even in its native habitat, and the following recommendations are based on the results of preliminary investigations made with a small number of suckers received by this Department from the Royal Botanic Gardens, Kew. These young plants are being cultivated under conditions similar to those under which the plant flourishes in its native country.

Young plants or suckers, which have been exposed to a long sea-voyage, should be planted as soon as possible about 18 inches apart in specially prepared, raised, nursery beds, consisting of soil having a fair proportion of sand and humus. The beds must be shaded with attaps, placed from 4 to 5 feet above the ground.

It is important to see that the soil around each plant is well pressed down, otherwise the plants may wither. They should be watered when necessary and remain in the nursery beds until established.

When large quantities of the suckers are being planted it is convenient to have the nursery beds about 100 feet long and 5 feet wide, giving three rows of plants in the bed.

Later, when local planting material is available, nurseries may be unnecessary, since the suckers will be probably sufficiently strong to allow of planting direct in the field.

The land selected for the cultivation should consist of dense jungle, with preferably a sandy loam soil. The undergrowth should be cleared, leaving only the larger trees and palms to form

sufficient shade for the protection of the plants. When transplanting the suckers into the cleared jungle, the plants should each be taken up with a good ball of earth, so that the roots are disturbed as little as possible. The most suitable planting distance is about 10 to 12 feet apart.

It has been shown by experiments carried out by the Department of Agriculture that this plant cannot be grown in the open, nor does it appear to thrive even when shaded by mature rubber, and therefore the provision of shade as described above is absolutely essential.

EXTRACTION OF FIBRE.

The native method of extracting the fibre is as follows:—The leaf is laid on a flattened log and the native, holding one end of the leaf with his foot, scutches away the waste material by means of a long stick with a flattened end, until only the fibre remains. This is a slow and wasteful method and commercially impracticable.

Considerable difficulty has been experienced in designing a satisfactory machine for the decortication of this fibre on a commercial scale to replace the native method described above. It is stated, however, that these difficulties have now been overcome, although no details of the new machine are yet available.

YIELD OF FIBRE.

Mr. Dawe refers to the probable production of fibre as follows:—“A surveyor, who has made a careful survey of the Chiriguana forests, estimates that the “pitaes” contain from 5,000 to 8,000 plants per acre, and even more in the richer parts. Sisal or henequen is planted in East Africa at from 900 to 1,000 plants per acre, in certain other countries as many as 2,000 plants are put to the acre; it will therefore be seen that the natural stocking of these “pitaes” is very much higher than the usual stocking per acre of sisal plantations.”

“It is estimated that the Pita plant will afford 30 leaves per year in two cuttings (in Mexico the henequen plant yields 25 leaves per plant per annum). If we take, to be conservative, the minimum stocking above referred to, viz., 5,000 plants per acre, there would be an annual production of 150,000 leaves per acre. Now 100 leaves weigh from 66 to 70 lbs., according to two independent experiments, so taking the mean of the two computations, viz., 68 lbs., the 150,000 leaves should weigh 102,000 lbs.”

“It has been found that, by the native hand method of extraction every 100 leaves or, say, 68 lbs., yields 2 lbs. of dry fibre. It is calculated, however, that there is a loss approximating to nearly 40 per cent. of the actual fibre content of the leaf, which would therefore be about 5 per cent. Allowing, however, for the recovery of only 3 per cent. by mechanical extraction, it will be seen that the return per acre should be 3,000 lbs. or, say, about 1½ tons of dry fibre.”

As a plantation proposition, with a planting distance of 10 feet apart either way, giving 435 plants per acre, it is obvious that the above estimate would, until the plants commenced to sucker, have to be reduced, to at least a tenth part of the amount of dry fibre shown, viz., $2\frac{1}{2}$ cwt. of fibre. No information is available at present as to the rate of suckering of the plants, but it is to be seen, that, unless this is fairly rapid, comparatively poor yields of fibre in the earlier years of production will be forthcoming, if the estimate given by Mr. Dawe is correct. Further investigations may show the advisability of closer spacing of the plants.

COMMERCIAL VALUATIONS OF FIBRES.

A sample of the hand-prepared fibre from the Chiriguana "pitales" was forwarded in 1918 to the Imperial Institute, London by Mr. M. T. Dawe, F. L. S., for examination with the following results:—

		Per cent.
Moisture		9.8
Ash	(calculated on dry fibre)	0.6
a-hydrolysis, loss	" " " "	12.6
b-hydrolysis, loss	" " " "	16.8
Acid purification, loss	" " " "	2.7
Loss on washing in water	" " " "	2.1
Cellulose	" " " "	74.7

Length of ultimate fibres: from 1.7 to 6.1 mms., mostly 3.0 to 4.2 mms.

"The sample consisted of clean, well-prepared, soft, lustrous fibre of pale straw tint. The fibre possessed good strength and varied from $8\frac{1}{2}$ to $10\frac{1}{2}$ feet in length.

Commercial experts, who reported on the value of this fibre for the Imperial Institute, stated that it was somewhat similar to sisal hemp obtained from *Agave cantala* in the Philippines and the Dutch East Indies, and that the strands were fairly fine, of good strength and thoroughly well-decorticated. They considered that this fibre could be used as a substitute for sisal hemp, Manila hemp or other hard fibres."

In January 1917 a sample of this fibre was submitted to the fibre expert of the United States Department of Agriculture, who reported as follows:—

"The fibre is of excellent quality, and there would be doubtless no difficulty in finding a ready market for it in this country at the present time at a price equal to that of henequen of Yucatan, *Agave fourcroydes*. It seems very doubtful whether American manufacturers would pay for the fibre in quantity, as much as the retail prices for small lots sold in Colombia. If it can be produced in quantity, however, there would be a ready market for it in this country in lots of many tons.

Further samples have been submitted to merchants and manufacturers and other offers to take the Pita fibre in quantities of 1,000 tons have been received. A large consumer, recognising the excellent qualities of the fibre, has offered to take the whole output of the "pitales" of Chiriguana for the period of three years, giving the current market price for sisal. An important fibre broker judged it "the finest fibre possible."

A sample of the "Arghan" fibre submitted by the Department of Agriculture to the Malay States Information Agency, London for valuation was reported on by Messrs. Cross & Bevan, Analytical and Consulting Chemists as follows:—

"Gentlemen, at the request of the Federated Malay States Government we have submitted your fibre to full investigation, and we may at once say that of the innumerable fibres submitted to us during our long professional practice, of potential industrial importance, Arghan stands out pre-eminent.

The structural qualities of the strands are remarkable, the breaking strain, determined on silk-testing machines, gives number, for weight/length unit, superior to those of the staple textile fibres of all classes. Those who have technical experience will find this statement justified by the following figures, noting that the tests were made on the untwisted strands of the original fibre.

We find a range of 3.0 to 6.1 grammes per 1 denier, for breaking strains; and extensibility 1.8 to 2.5 per cent. The 'tenacity' figures are quite remarkable, and they establish the Arghan fibre and fibre substance as a new and exceptional type.

Composition of fibre substance.—The samples have characteristics of high standard; the state of preparation probably admits of improvement, when the extraction and purification of the fibre has been reduced to industrial routine.

(1) The percentage of cellulose, 75, is above the average for fibres of this class.

(2) The resistance to alkaline hydrolysis (caustic soda) is good. The above characteristics are those which would be favourably affected by standardised methods of preparation.

(3) The fibre is remarkably free from lignone. The fibre should take premier place as a staple for fine twine, lines and cordages, and from the sample of cloth which you have submitted to us, its textile possibilities are shown to be very considerable.

Sea-Water Immersion Tests.—We subjected a sample of the original fibre in the free state to a month's immersion in the ocean tank at the Biological Station, Plymouth, and it is satisfactory to note that the degree of chemical resistance of the fibre was of a very high order. In the same circumstances, cotton, flax, etc., would have been degraded in composition and entirely disintegrated as regards

structure. On the result of our investigations, which have been prolonged, we have formed a strong view of the importance of your fibre as a technical discovery of great industrial importance."

There is therefore no doubt as to the commercial value of this fibre, and that there exists a ready market at prices equal to the best sisal or Manila hems which at the present time (March 1924), are approximately £10/- a ton. It is possible that when the fibre is better known it will command a still higher price than either of these fibres on account of its fineness, strength and durability.

USES.

The Pita fibre is valued by the native of Colombia as the strongest and most durable of its class. Large quantities are used in the manufacture of fishing nets, and for saddlery and leather work. It is also employed for fancy needlework.

Commercially it would be classed as a hard fibre and would enter into competition chiefly with sisal for the manufacture of cordage.

Experiments have been carried out recently with a view to its use as a substitute for silk and the manufacture of cloth with promising results. It is stated to take dyes better than any other fibre of its class. If used for such purposes this fibre would naturally realise much higher prices than if used merely in competition with sisal hemp.

It also possesses remarkable salt-water resisting properties and is therefore useful for the manufacture of fishing net yarns and other classes of marine ropes.

CONCLUSIONS.

It should be clearly understood that, although the results of investigations of the fibre are so promising, little information is available regarding either the cultivation of this crop or its yield of fibre under plantation conditions. The plants have been introduced only recently into this country and only when they have reached maturity will it be possible to give a definite opinion as to whether this crop is likely to prove a commercial success. It is as yet too early to say whether the plants will sucker sufficiently to form the dense growth referred to as "pitales." Unless this occurs, it is difficult to see, with the estimated yields available, a return of fibre of sufficient quantity to compete with the other well-known fibres of commerce.

Received for publication 17th May 1924:

PATCHOULI OIL.

By B. J. EATON AND C. D. V. GEORGI.

A revival of interest has been shown recently in the production of patchouli oil and several communications have been received from England enquiring as to the present position of the industry in Malaya, which supplies the bulk of the oil of commerce.

In addition, enquiries have been received from two other countries as to the method of treatment and distillation of the leaf in this country.

Apart from the local distillation, considerable quantities of the dried leaf were exported formerly to Europe and America for distillation. The distillers in these countries prefer their own distilled oils owing to the possibility of adulteration of the imported oils.

HISTORICAL.

In the latter part of the last century both the cultivation of the patchouli plant and the distillation of the leaf for the production of oil were of considerable importance as a minor industry in Malaya, chiefly on the island of Singapore.

At that period three European distilleries were in existence, the plant being also cultivated locally by the owners of the distilleries. The cultivation of the plant was also carried on by a large number of Chinese small holders on areas of about $1/2$ to 1 acre, the small holders selling the dried leaf either to dealers or distillers.

The industry did not continue to flourish, probably owing to over-production, adulteration and other causes, and two of the distilleries ceased production.

For several years the industry was continued on a very limited scale and passed gradually into the hands of enterprising Chinese. In 1908 Tan Ah Tian of East Coast Road, Singapore, who was then distilling citronella oil on a small scale, commenced the distillation of patchouli oil. From that year until about 1919 the production of the oil was carried out only on a small scale, the oil produced by the Chinese distillers being sold in Singapore to dealers, who supplied the European and American markets.

In the post-war boom of 1919-1920 Tan Ah Tian decided to extend his enterprise and, owing to the high prices then ruling for the product, commenced to export the oil himself, since with his past experience he was able to produce the grades of oil favoured by various buyers in Europe.

This business which is carried on under the name of Chua Seng Heng & Co. is now controlled by the son, Tan Guan Chua, who continues the direct export of the various grades of oil. The capacity of this distillery, which is at present the largest in Malaya, is given as 3,000 to 4,000 lbs. of oil per month.

Recently another grower and distiller, Low Ting Teng (Chop Tye Sin) in Johore has entered this industry. A short account of the cultivation and distillation methods carried out by this distiller has been given in a previous number of this journal (Vol. XII, No. 1. January, 1924). The present capacity of this distillery is about 1500 lbs. of oil per month.

Other distilleries are still in existence in Malaya but are not at present in operation.

VARIETIES OF PLANT.

Patchouli oil is distilled from the leaves of the plant *Pogostemon Patchouli*, var (*suavis*) Hk. (*Pogostemon Cablin*, Benth.) Natural Order, Labiatae. The plant is usually referred to as *Pogostemon Cablin*, Benth. The word *Cablin* is derived from Cablan, the vernacular name for the plant in the Philippines, where it appears to be indigenous.

There are a number of other varieties of this plant, including *Pogostemon Heyneanus* (Benth.), which also yield essential oils, but the genuine patchouli oil of commerce is produced only from the variety mentioned in the preceding paragraph. The leaves from these other varieties, together with those of other plants, chiefly of the Natural Order Labiatae, are stated to be used as adulterants, especially when the leaves are sold for export. The variety *Pogostemon Heyneanus* (Benth.) is a native of India, where it is grown in gardens; it is also cultivated on a larger scale in Java.

Owing to the intense characteristic odour of the genuine leaf, which is imparted to other leaves of similar appearance used as adulterants, detection is difficult.

CULTIVATION AND COLLECTION.

The cultivated plant is a herbaceous perennial propagated by means of stem cuttings, raised first in nursery beds and later transplanted into the field at distances of about 3 feet by 3 feet. In some cases the cuttings are planted in the field and shaded until established.

The first cutting of the stems can be made after about five to six months and subsequent cuttings after similar periods, depending on the character of the soil, rainfall and other climatic factors. Regular cutting can be carried out for about two years, after which replanting is necessary.

The plant appears to thrive on good undulating land or on low-lying land with efficient drainage. Virgin jungle land, which gives the highest yields, is usually selected.

The stems are cut with a sharp knife or scissors at a short distance from the base and transported to the distillery.

The stems and leaves are spread to dry in thin layers on open cement floors with frequent turning to ensure rapid and uniform drying. In case of rain the material is protected by a suitable covering and is removed under sheds at night to protect from dew. It is stated that the stem yields only a small quantity of oil and that of an inferior quality; on that account sometimes the leaf only is distilled, being stripped from the stems before drying.

In the Johore distillery mentioned above the stems and leaves are dried as described and stored under attap roofed sheds, under which conditions it is probable that a slight fermentation takes place in the heaps.

De Jong, who has carried out experimental investigations on the distillation of this oil, states that the wilting effected by the drying and fermentation of the leaf causes the oil cell walls to perish, thus liberating more oil.¹

The yields obtained by De Jong from dried or fermented leaf (calculated on fresh material) were similar and about $2\frac{1}{2}$ to 3 times the yield from fresh leaf. The character of the Singapore oils was only slightly affected by fermentation or drying, while the fermentation and drying of the Java leaf had a marked effect on the character of the oil.

No information is at present available as to whether the Singapore distillers adopt any special methods of fermentation in the preparation of oils of special quality.

DISTILLATION OF OIL.

The oil is obtained by direct steam distillation of the dried material. A number of stills are connected to a main boiler in which the steam pressure is raised to about 75 per lbs. per square inch.

The stills consist of cylindrical iron vessels, about 6 to 7 feet high and 2ft. 6 inches in diameter, having a capacity of about 2 piculs of dried material.

The material is placed in a number of wire cages or deep trays, which are hung inside the stills by means of wires, in order to facilitate charging and discharging.

In the Johore distillery the dried material is first damped before being placed in the stills. It is possible that the reason for this is to enable a larger charge of material to be packed in the still.

Steam from the main boiler enters the still near the bottom through a 2 inch pipe; the outlet pipe is placed near the top of the still, opposite the inlet pipe, and is connected to a copper condensing coil immersed in a large tank through which cold water circulates.

¹ Tesymannia 1906 and 1909.

A battery of stills in a row, supplied by steam from the main boiler can be connected to a series of condensing coils contained in one large tank.

The condensing coils deliver the condensed water and oil into a trough which leads into a sump, constructed like a Florence flask. The oil is skimmed off and filtered through dry filter paper to remove small amounts of water and any suspended matter.

The distillation of a charge in stills of the above capacity is continued for about 24 hours.

Although the above is a general description of the method of distillation of the oil, it would appear that oils of special quality can only be prepared by varying the conditions, the details of which are known only to experienced distillers.

Chua Seng Heng and Co., prepares four grades of oil, known respectively as "Ordinary", "Medium", "Special" and "Extra Special". Analyses of these grades are given in Table I.

YIELDS.

A yield of over a half a ton of air-dried leaf can be obtained per cutting from a good first crop and a similar yield has been obtained with a second cutting six months later. The subsequent yield of leaf will decrease and after two years it will be found necessary to replant.

In the Johore distillery, in which the stems and leaf are distilled together, the yield of oil is about 4 to 6 lbs. per charge of 2 piculs of air-dried material. (1 picul 133 $\frac{1}{3}$ lbs.)

ANALYSIS OF OIL.

Figures for the analysis of the four grades of oil distilled by Chua Seng Heng & Co., are given in Table I. For comparative purposes figures for the analysis of oil distilled by Low Ting Teng (Chop Tye Sin) and also those for standard Singapore distilled oils (Singapore leaf) are given. The figures for the standard Singapore and European distilled oils have been taken from "The Volatile Oils" Gildemeister and Hoffman, Second Edition by E. Gildemeister (translated by Edward Kremer) Vol. III.

The grade of oil is indicated by (a) the difference in specific gravity which rises with the "higher" grades and (b) solubility in alcohol 90 per cent. by volume.

The grades of oils examined also show an increase in laevorotation in the "higher" qualities.

The results of analysis of these oils show that the "Ordinary" and "Medium" grades correspond to the Singapore oils of commerce, while the "Special" and "Extra special" grades correspond more closely to the European distilled oils.

TABLE I.—TABLE SHOWING THE RESULTS OF ANALYSIS OF VARIOUS SAMPLES OF PATCHOULI OIL.

Constant.	Oils from Chua Seng Heng & Co.					Oil from Low Ting Teng & Co.	Average for Singapore distilled oil.	Average for European distilled oils (Singapore leaf).
	Ordinary Grade.	Medium Grade.	Special Grade.	Extra Special Grade.				
Specific Gravity (15.5°C) ...	0.9696	0.9740	0.9814	0.9892		0.9711	0.960 to 0.980	0.966 to 0.995
Optical Rotation ...	-48°.4'	-52°.48'	-53°.48'	-55°.2'		-48°.28'	-47° to -61°	-50° to -71°
Acid Value ¹ ...	2.3	2.8	3.5	3.7		2.2	Up to 1.0	Up to 5.0
Ester Value ¹ ...	4.1	2.3	3.8	3.6		3.0	1.5 to 7.0	2.0 to 12.0
Solubility in 90 per cent. alcohol, by volume:								
(a) 15°C ...	Sol. in 6.5 vols.	Sol. in 0.75 vols.	Sol. in 0.5 vols.	Sol. in 0.5 vols.		Sol. in 0.6 vols., addition of from 1.5 to 3 vols. causes turbidity, the sol. becomes clear again on further dilu- tion.	Some oils sol. in 0.5 to 1 vol., mostly however in 5 to 8 vols.	Mostly sol. in 0.5 to 1.5 vols., addition of more solvent occasionally causes tempor- ary turbidity. Some oils only sol. in 4 to 6 vols
(b) 28°—29°C ...	Sol. in 0.75 vols., addi- tion of from 1.3 to 5 vols. causes tur- bidity the sol. becomes clear again on further dilution.	Sol. in 0.75 vols.	Sol. in 0.75 vols.	Sol. in 0.4 vols.		Sol. in 0.5 vols.		

1 Milligrammes of potash for 1 gramme of oil.

USES.

Pure patchouli oil has a somewhat strong and pungent odour, but, when diluted with alcohol or spirit, the odour becomes pleasant. The oil is used almost exclusively in the preparation of compound perfumes in which the odour harmonises with that of the other ingredients.

MARKETS AND VALUE OF OIL.

At the present time the principal markets both for the oil and leaf are Great Britain, The United States of America and Japan. Several enquiries for the oil and leaf have been received recently from London.

In the "Drug and Chemical Markets" (Vol. XIII, No. 22, New York, November 28th, 1923) it is stated that 90 per cent. of the leaf which is dealt with in Singapore is grown in Sumatra. The balance is grown in Malaya. The imported leaves are shipped in bales of about 280 lbs. covered with sacking. In the case of leaf exported from Malaya, the principal destination is the United States of America.

The average local production of oil is 2,000—3,000 lbs. per month. The oil is shipped in 20 lb. iron drums packed in sawdust, two in a case.

In the first seven months of 1923 the value of the exports of patchouli oil from Malaya amounted to \$206,116/-.

The price of patchouli oil has fluctuated considerably during the last three years. In 1920 the oil was valued at \$33/- per lb., but the price has since declined, until at the present time the oil realises only about \$8/- per lb.

In America an import duty of 20 to 25 per cent. on the value of the oil has been imposed. The American demand therefore is principally for leaf for distillation in the country.

No import duty is imposed in Great Britain and there is also no export duty in Malaya.

CONCLUSIONS.

While it is of interest to note the revival of this minor agricultural industry in Malaya, attention should be drawn both to the fluctuating prices and the probability of over-production. Such a product must be regarded as a luxury and not an essential article of commerce; its value therefore will depend always on the wealth of the population which can be diverted to the purchase of such materials.

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VETIVER OIL.

By C. D. V. GEORGI.

VETIVER oil, an essential oil, is obtained by the distillation of the roots of the vetiver plant. This plant is a perennial grass, belonging to the same Natural Order—Gramineae—as citronella grass and lemongrass, in which the leaves contain the essential oil. In the case of vetiver it is interesting to note that the leaves are odourless, the roots being the only part of this plant which yield an oil on distillation.

It is thought that the publication of the results of an investigation carried out recently at the Department of Agriculture will be of interest in spite of the fact that there is only a very limited demand for this oil.

The supply of roots for the experiments was obtained from the Government Experimental Plantation, Serdang, where small areas of this crop are under cultivation.

The roots have been distilled to determine the yield of oil and samples of the oil have also been forwarded to the Malay States Information Agency, London for valuation.

NAME OF GRASS.

Vetiver grass is known botanically as *Vetiveria zizanioides*, Stapf.

This grass is but little known in this country; in India, where it is found widely distributed and where the dried roots are used for a variety of purposes, it is known as *Cus-Cus* or *Khas-Khas*. The dried roots are made into baskets and mats (chicks), the latter being hung on verandahs and moistened with water in hot weather, thus perfuming the atmosphere. Bundles of the roots are also placed between clothes stored in wardrobes or boxes, imparting to the clothes the odour of the essential oil, which in its diluted state resembles sandal wood.

In Java there is also a trade in the dried roots, which are known as *akar wangi*, signifying aromatic root.

Vetiver is also cultivated in Reunion; the root is distilled locally, and the oil exported to Europe.

CULTIVATION OF GRASS.

The grass is propagated by root division and appears to flourish best in a light soil, which favours root development. In India, where this plant occurs wild, it is found principally along the banks of rivers and in rich marsh land.

The plant will not thrive under shade, while it is said that root development is stimulated by frequent cutting of the grass.

It has been found that the oil content increases up to the time of flowering, so that if the roots are required for distillation they should be harvested just before this time.

EXTRACTION OF OIL.

The roots are dug up, separated from the stems and washed in running water to remove adhering stones and soil, and then steam-distilled. On account of the low volatility of this oil the distillation is lengthy, requiring several hours to complete. In the investigations carried out in the Department it was found that a period of about 10 hours was required to complete the distillation of a batch of roots.

YIELD OF OIL.

The yields of oil obtained from fresh air-dried roots varied between 0.50 and 0.65 per cent. by weight, that is to say, 1 ton of roots will give 12 to 14 lbs of oil. The weight of roots obtained from the experimental areas was at the rate of about half a ton per acre, corresponding therefore to a yield of 6 to 7 lbs. of oil per acre per crop. Under normal conditions two crops of roots can be obtained per annum, equivalent on the above figures to a yield of 12 to 14 lbs. of oil per acre per annum.

VALUE OF OIL.

The sample of oil despatched to the Malay States Information Agency for valuation was forwarded to the Imperial Institute for report. The following is an extract from their report :

"The sample consisted of a viscid, dark greenish-brown vetiver oil of good aroma. It was examined with the following results, which are shown in comparison with corresponding figures recorded for (a) oil distilled in Europe from dry imported roots and (b) oil distilled in Reunion.

	Present sample.	European distilled oil.	Oil distilled in Reunion.
Specific Gravity at 15/15°C ...	1.032	1.014 to 1.042	0.982 to 1.020
Optical Rotation... Too dark to permit reading		+25° to +40°	+20° to +28°
Refractive Index 20°C. ...	1.524	1.520 to 1.523	1.515 to 1.528
Acid Value ...	35.5	25 to 65	4 to 20
Ester Value before acetylation ...	11.8	10 to 25	5 to 20
Ester Value after acetylation ...	162.0	130 to 160	120 to 150

These results show that the present sample of oil is of normal character.

COMMERCIAL VALUATION.

The chemically dried oil was regarded by experts as of good aroma, resembling in this respect Réunion vetiver oil rather than Indian. They considered that it would be worth 30s. per lb. ex wharf London (January 1924) but were of opinion that the price of vetiver oil might fall in the near future."

USES OF OIL.

Vetiver oil is used exclusively in the preparation of compound perfumes, in which the oil, on account of its low volatility, acts as a valuable "fixer" for more volatile essential oils.

As in the case of other essential oils the utilisation of which is restricted to similar purposes, it is unlikely that the demand for this oil will ever be extensive.

Received for publication 5th April 1924.

1.

TITI SERONG RICE EXPERIMENT STATION.

By H. W. JACK.

IN view of the increasing interest which is being shown in experimental work with rice, it has been suggested that a brief note describing the principal experiment station under the auspices of the Agricultural Department should be published.

The principal rice experiment station is situated at Titi Serong, which is three miles distant from Parit Buntar, the head-quarters of the Krian District of Perak, a district well-known on account of the excellent irrigation scheme established by the Government some twenty years ago to irrigate 56,000 acres of flat clay land for rice cultivation, and for the prosperous condition of its population which is almost entirely agricultural.

The station comprises approximately 21 acres of good padi land and was selected in the first place, because it is the centre of a thriving cultivated area; and secondly, because it is abundantly supplied with water since a distributary channel from one of the branches of the main irrigation canal discharges water almost directly in the area.

Unfortunately, though the land is so well supplied with water there is great difficulty in draining off the land prior to harvest and maintaining it dry for the few months between the seasons, because the whole area appears to be situated in a slight depression of the land and because the nearest outlets for excess water are some miles distant, and these outlets themselves are becoming shallow and choked with silt deposit and need dredging periodically. Consequently, whenever rainy weather occurs during the harvesting period it is impossible to drain the land and harvesting operations have to be carried on in 6 or 8 inches of water or more, rendering the labour more arduous and causing considerable loss of crop. This drainage difficulty was only discovered 2 years after work had commenced when a wet harvest was encountered.

In the third place, this land was selected because it was the best available area within a reasonable distance of Parit Buntar town where the Officer-in-Charge of the station resides.

The land lies adjacent to a fairly good road from which there is a cart entrance to the commodious field store standing at the west end of the fields which run from East to West.

The field store in essentials consists of a cement paved floor, 2,500 square feet in area, covered by a tiled roof and fenced on the east by expanded metal and on the remaining sides by plank walls. One-third of the store is rendered rat-proof by means of half-inch mesh wire netting. This part, amply provided with tiers of shelves,

constitutes the temporary field store as distinct from the main part of the building which is more a covered working space for threshing, winnowing, and other operations connected with harvest, than a store.

Attached to the field store is a tiled drying floor, 1,200 square feet in extent, suitably inclined to facilitate rapid drying and raised one-and-a-half feet above the general ground level. This drying floor is most useful, not only for drying padi, but as a solid platform on which to deal with numerous lots of padi, for it must be remembered that the ordinary soil level is often moist and in rainy weather is frequently submerged even during harvest.

When lots of padi are quite dry they are bagged and labelled and removed to Parit Buntar to the permanent rat-proofed store, to await distribution or study of characters required for definite records. This permanent store is part of the ample building which is used as an office and laboratory by the Officer-in-Charge, locally, of padi experiments.

The land at Titi Serong is divided by "batas" into four "bendangs," each "bendang" being about 5 acres in extent and averaging approximately 600 yards in length.

The work carried on in the station has already been described in Bulletin No. 35 of this Department, but it may be mentioned that the chief item in the programme of experiments is the selection of heavy yielding strains of padi, their isolation, field testing and finally, their multiplication for distribution to rice planters with a view to raising the average annual crops obtained in the country.

Other experiments embrace variety tests, milling tests, the effects of manures and of different methods of cultivation, crop rotation, and cross breeding between the best selections and strains showing desirable characters for the purpose of endeavouring to establish still better strains.

Already the main work, selection, is showing good results and several strains of seed which have been distributed have proved better than local unselected seed in various parts of the country, but particularly in the Krian District in which it is estimated that at least 1,500 acres were planted with selected strains during the last season, in practically every case, with benefit to the planter.

Wherever selected seed was grown in the last season, it attracted considerable attention not only on the part of the Malays but also on the part of the Chinese, who cultivate some 10,000 acres of padi in the Krian District, and demands for seed for the next season are already numerous. Selected seed is popular not only because it produces a large crop but because the padi is heavier than that derived from unselected seed by at least 8% since all the grains are well filled—a result of selecting the seed solely on weight returns; moreover, selected grain gives a high percentage of rice in milling. Amongst other prominent characteristics of selected seed is its absolute uniformity in maturation (which reduces loss in harvesting to the minimum) and the absence of too much foliage.

In March last, the station was favoured by a visit from H. H. The Sultan of Selangor and his staff, the Dato Lee Kong Lam and several notable Malays from Selangor, Negri Sembilan and Perak, and some 250 other interested persons in different part of the country. H.H. The Sultan of Selangor showed great interest in the work; that he possessed a considerable knowledge of things appertaining to padi cultivation was amply evidenced by his pertinent questions and remarks.

Through the Inspection Division of the Department, tests of various selected strains are being carried out in different parts of the country, where conditions differ from those existing at the Titi Serong Station, to ascertain whether some of the strains already selected may be suitable for other areas as well as in Krian. In this way, strains selected in Krian have been found useful in various other places, and are gradually displacing the varieties previously grown. A limited quantity of selected seed padi is now available for distribution to applicants who should communicate with the Economie Botanist, Department of Agriculture, Kuala Lumpur. Rice work is still in its infancy in Malaya, but continuity and perseverance promise beneficial results in increasing local yields and reducing the very large annual imports of the chief food of our labouring population.

Received for publication 8th April 1924.

SMALL POWER RICE MILLS FOR ESTATES.

THE adoption of small power mills for hulling padi is slowly but surely gaining favour on estates situated within easy distance of regular padi markets.

This course of events is only natural becomes those estates which have been the pioneers in establishing their own mills have found them to be greatly advantageous.

Amongst the advantages which have been found to accrue from estate milling, the most important consideration is the effect on the labour employed. On one estate it has been found possible to purchase padi, mill it, and sell the rice to the coolies at 7-9 cents per gantang cheaper than the neighbouring shop rates after deducting a small percentage of the profits towards covering capital expenditure and depreciation.

This large reduction in the price of estate milled rice as compared with rice bought in the local shops is, of course, only possible to the estate referred to, because it is particularly conveniently situated as regards a padi market, but there are many other estates in the north of the Peninsula which could purchase padi almost as easily. For instance, another estate located several miles from a padi market retails estate milled rice to its own labour at 4 cents a gantang less than the local 'kedai' price.

Thus by milling their own rice, estates situated near areas where rice production is in excess of the demands of the local population can supply their labour forces with rice at a rate varying from a small percentage up to something around 15% less than the local market rates.

This reduction in the cost of rice, small as it may seem, is a very material consideration with coolies, particularly as the cheaper price is also coupled with full measure as compared with the usual shop-keeper's method of giving short measure, and tends to stabilise labour on these estates.

Moreover, estate milled rice (parboiled) is sweeter in flavour than commercial rice, because the water in which the padi is soaked before milling is changed, and is consequently cleaner.

Received for publication 17th March 1924.

AGRI-HORTICULTURAL SHOW AND TRADES EXHIBITION.

WE have received a copy of the Agriculture section schedule in connexion with the forthcoming Agri-Horticultural Show and Trades Exhibition, to be held on the Race Course, Kuala Lumpur on July 11th, 12th and 13th, 1924. The schedule is comprehensive and the prizes offered are considerable. We note that, in the main classes for Rubber, exhibits are to consist of a whole case: this should make for fairer judging, as the exhibits will be, presumably, of average commercial standard. The Section Secretary is Captain J. M. Howlett, M.C.; and copies of the schedule can be obtained on application either to him or to the Hon. Secretary, M.A.H.A., P.O. Box 274, Kuala Lumpur.

(7-6-24.)

LONDON MARKET PRICE LIST, 2nd QUARTER 1924.

Oil Seeds.

Castor (Bombay)	-	£24.	per ton.
Copra (Ceylon)	-	£29.	" "
Do. (Straits)	-	£26.15	" "
Cotton (Egyptian)	-	£13.2.6.	" "
Do. (Bombay)	-	£10.	" "
Croton	-	£27/6—32/6	per cwt.
Desiccated Coconut (fine)	-	41/-	" "
Do. Do. (medium)	-	44/-	" "
Do. Do. (coarse)	-	45/-	" "
Gingelly (Chinese)	-	£25.10.	per ton.
Do. (Bombay)	-	£25.17.6	" "
Groundnuts (Gambia, undecorticated)	-	£15.15.0	" "
Do. (Chinese, decorticated)	-	£21.7.6	" "
Linseed (Bombay)	-	£20.2.6	" "
Do. (Plate)	-	£17.13.9	" "
Palm Kernels (West Africa)	-	£18.15.	" "

Oils.

Castor (Madras)	-	58/6	per cwt.
Do. (pharmaceutical)	-	69/-	" "
Do. (1st pressing)	-	64/-	" "
Do. (2nd pressing)	-	62/-	" "
Coconut (Cochin)	-	50/-	" "
Do. (Ceylon)	-	44/-	" "
Cotton seed (Egyptian, crude)	-	39/9	" "
Do. (Bombay)	-	37/-	" "
Groundnut (Oriental, crude)	-	46/-	" "
Do. (English)	-	47/-	" "
Linseed (Calcutta)	-	39/-	" "
Do. (Plate)	-	38/-	" "
Palm (Lagos)	-	£36	per ton.
Do. (Sumatra)	-	£35.17.6	" "
Palm kernel	-	40/-	per cwt.

Oil Cakes.

Coconut	-	£9.10	per ton.
Cotton (Egyptian seed)	-	£8.	" "
Do. (Bombay seed)	-	£7.	" "
Groundnut (undecorticated)	-	£9.17.6	" "
Linseed	-	£10.15—£11.15	" "
Palm kernel	-	£7.5	" "

Essential Oils.

Cajeput	-	3/2—3/3	per lb.
Camphor (Chinese, crude)	-	2/10	" "
Do. (Japanese, refined)	-	3/1½	" "

Essential Oils.—contd.

Camphor (oil)	- 62/6—65/- per cwt.
Cinnamon (Ceylon, leaf)	- 5½ per oz.
Citronella (Ceylon)	- 3/6—3/7 per lb.
Do. (Java)	- 5/- " "
Clove	- 7/6—7/9 " "
Lemon grass (Cochin)	- 3/10 " "
Lime (West Indian, expressed)	- 9/- " "
Do. (" " , distilled)	- 5/- " "
Patchouli (Penang)	- 18/6 " "
Do. (Mysore)	- 25/- " "
Vetiver (Bourbon)	- 46/- " "

Spices.

Capsicums (East Indian)	- 40/- —45/- per cwt.
Do. (Nyassaland)	- 60/- —65/- " "
Chillies (Zanzibar)	- 40/- —45/- " "
Do. (Nyassaland)	- 50/- —55/- " "
Do. (Japan)	- 125/- " "
Cinnamon (Ceylon)	- 9d. —1/- per lb.
Cloves (Zanzibar)	- 11½d. —1/2 " "
Do. (Penang)	- 2/6—3/- " "
Ginger (Japanese, Cochin)	- 80/- —95/- per cwt.
Do. (Jamaica)	- 145/- —180/- " "
Mace (Bombay & Penang)	- 2/- —2/10 per lb.
Nutmegs (Singapore & Penang)	
110's	- 2/- " "
80's	- 2/2 " "
64's—57's	- 2/3—2/4 " "
Pepper (Singapore, black)	- 4½d. " "
Do. " , white)	- 7½d. —8d. " "
Turmeric (Bengal)	- 90/- per cwt.

Drugs.

Areca	- 45/- per cwt.
Cinchona Bark	- According to analysis
Cocaine (hydrochloride)	- 17/- —17/6 per oz.
Ipecacuanha (Rio)	- 9/- —9/3 per lb.

Natural Dyestuffs and Extracts.

Annatto (seed)	- 1/4—1/5 per lb.
Gambier (black)	- 65/- per cwt.
Do. (cubes)	- 75/- —80/- per cwt.

Gums and Resins.

Damar (Singapore)	- 30/- —150/- per cwt.
Do. (Batavia)	- 120/- —160/- " "
Dragon's blood (reeds)	- £18—£20 " "
Do. (lump)	- £11—£28 " "

Fibres.

Cotton (American Ord. to F. L. M.)	- 15. 45d.—17. 45d. per lb.
Do. (Egyptian Sakellaridis, G. F. to Fine.)	- 23. 40d.—25. 70d. " "
Hemp (sisal)	- £21—£46 per ton.
Do. (Manila, J. Grade)	- £39. " "
Do. (Mauritius)	- £33—£37 " "
Do. (New Zealand)	- £35—£37 " "
Kapok (Java)	- 1/2½ " lb.
Do. (Indian)	- 11d. " "

Foodstuffs.

Cocoa (Ceylon, plantation)	- 60/-—100/- per cwt.*
Coffee (Malay, plantation)	- 90/-—120/- " "
Do. (Malay, Liberian)	- 60/-—70/- " "
Sago (pearl)	- 28/-—30/- " "
Do. (flour)	- 17/6—18/6 " "
Sugar (white, Java)	- 25/6 per cwt. (ex. duty.)
Tapioca (Penang, flake)	- 3½d.—4d. per lb.
Do. (Penang, flour)	- 18/-—22/- " cwt.

Miscellaneous.

Guttapercha (genuine)	- 2/9—6/- per lb.
Do. (Sarawak)	- 3/-—4/- " "
Do. (Siak reboiled)	- 10d. " "
Jelutong	- £30—£60 per ton.

Chemicals.

Acetic acid (glacial)	- £71—£73 per ton.
Do. (80% comml)	- £47.10—£48.10 per ton.
Acetone (pure)	- £100—£101 " "
Ammonia (.880)	- £32—£34 " "
Calcium acetate (grey)	- £19.10—£20.10 " "
Citric Acid	- 1½/6 per lb.
Creosote	- 8d. per gallon
Formalin (40% vol.)	- £62—£63 per ton.
Lime juice (raw)	- 1/9—2/9 per gallon.
Do. (concentrated)	- £21 per basis.†
Sodium bisulphite, (60—62%)	- £20—£22 per ton.
Sodium sulphite (anhydrous)	- £26.10—£27.10 per ton.

* Prices of Cocoa and Coffee are given in bond.

† Basis — 108 gallons, 64 ozs Citric acid per gallon.

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Publications of the Department of Agriculture.

The following publications, except those out of print, may be obtained on application to the Office of the Secretary for Agriculture; the Raffles Museum, Singapore; and the Malay States Information Agency, 88, Cannon Street, E.C. London.

A remittance to cover the cost should accompany applications; otherwise the Journals will be sent by post, Cash on Delivery, where that system is in force.

1. The Agricultural Bulletin F.M.S.

Vols. I—IV (1913-16) VIII & IX (1920-21) price \$5.00 per volume.

Vol. V (1917) Nos. 1, 2, 3, 5 & 6 „ 2.50 per set.

„ VI (1918) „ 1, 7, 8 & 12 „ 2.00 „

„ VII (1919) „ 2—6 „ 4.50 „

2. The Malayan Agricultural Journal (continuing the Agricultural Bulletin). Published monthly.

Vol. X (1922) Price \$5.00 per volume.

„ XI (1923) Price \$5.00 per volume or 50 cents per single number.

Back numbers of Vols. I—X will not be sold singly.

3. The Handbook of Malayan Agriculture, price \$1.00.

Current numbers of the Malayan Agricultural Journal and the Handbook may be purchased at the Railway Bookstalls and Branches of Messrs. The Federal Rubber Stamp Co.

4. Special Bulletins.

1. Notes on *Termes Gestroi* and other species of Termites found on Rubber Estates in the Federated Malay States, by H. C. Pratt, Government Entomologist, 1909, 20 cts.
2. Root Diseases of *Hevea Brasiliensis*, by W. J. Gallagher. C
3. Observations on *Termes Gestroi* as affecting the Para Rubber Tree and methods to be employed against its Ravages, by H. C. Pratt, Government Entomologist, 1910, reprint 1916, 20 cts.
4. A Lepidopterous Pest of Coconuts, *Brachartona catoxantha*, Hamps, by H. C. Pratt, 1909. C
5. The Extermination of Rats in Rice Fields, by W. J. Gallagher, 1909. C
6. Preliminary note on a Branch and Stem Disease of *Hevea Brasilienensis*, by W. J. Gallagher, 1909. C
7. *Coffea Robusta*, by W. J. Gallagher, Government Mycologist, 1910, 20 cts.
8. The Cultivation and Care of the Para Rubber Tree (in Malay) 1910. C
9. Die-Back Fungus of Para Rubber and of Cacao, by K. Bancroft, 1911. C
10. A Lecture on the Para Rubber Tree, by W. J. Gallagher, 1910. C
11. Coconut Cultivation, by L. C. Brown, 1911. C
12. Padi Cultivation in Krian, by H. C. Pratt, 1911. C
13. A Root Disease of Para Rubber, *Fomes Semitostus*, by K. Bancroft, Assistant Mycologist, 1912, 20 cts.

C = Cancelled.